

# SCIENCE

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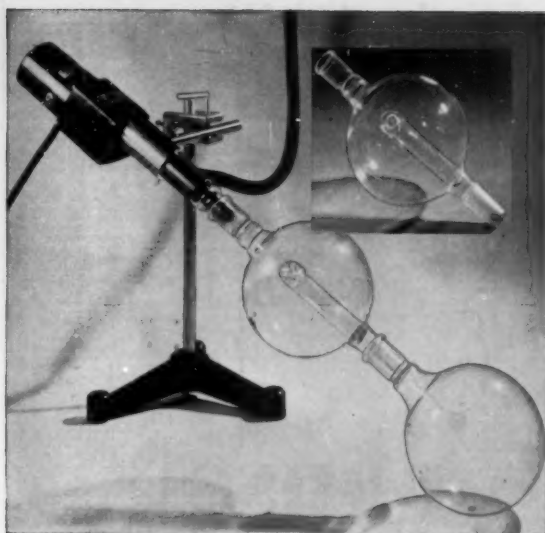
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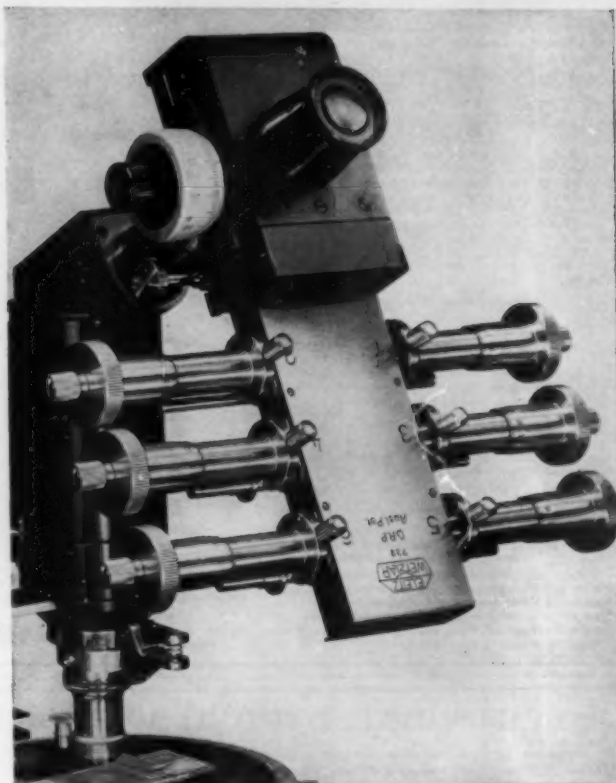
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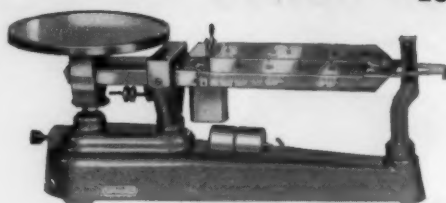
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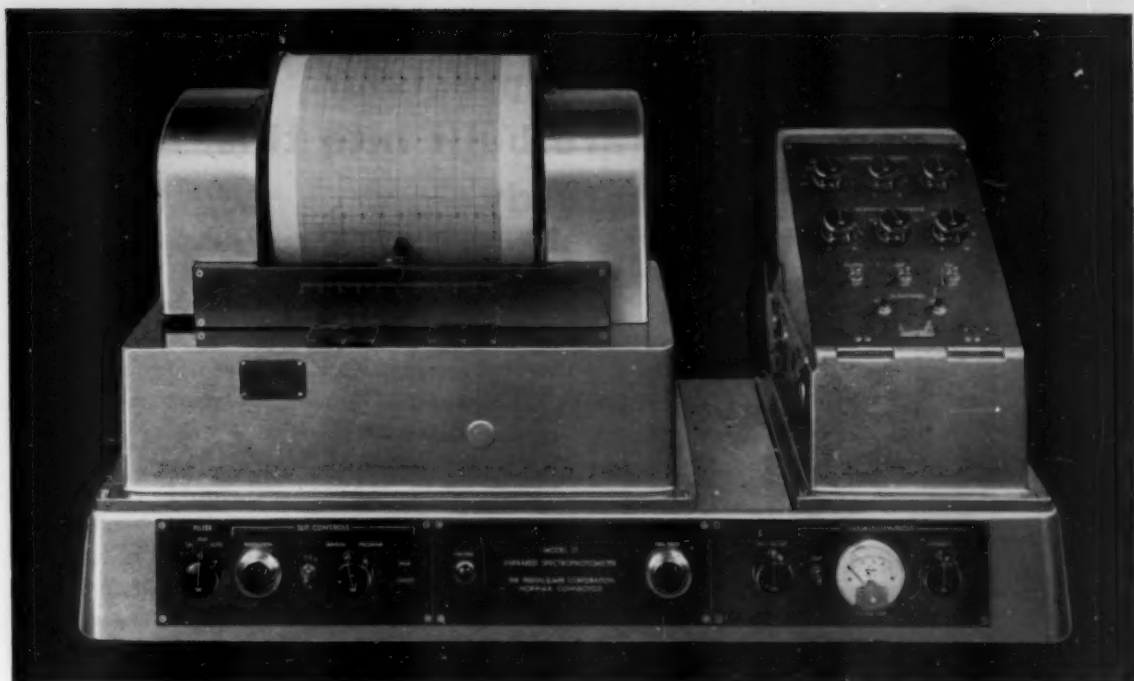
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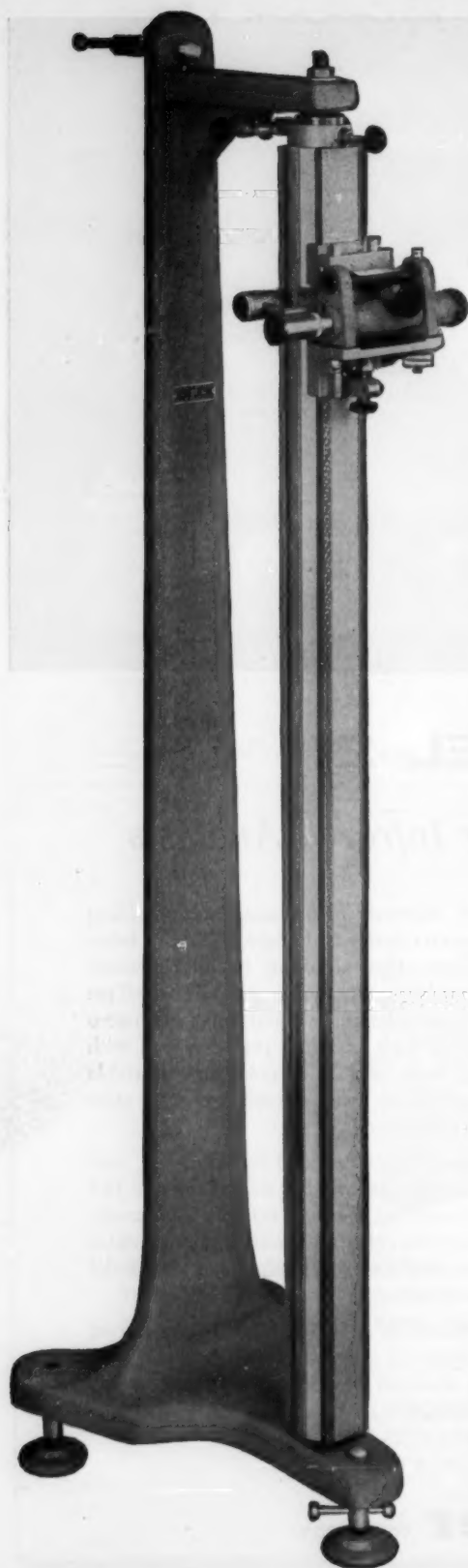
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## The Gold in Useless Knowledge

Discussion of the value of basic research is as pertinent today as it was when Faraday, queried about the usefulness of his discovery of electric induction, countered with the question, "Of what use is a newborn baby?" The recent American Foundation study entitled *Medical Research* gives eloquent testimony to support the view that the solution of our major medical problems depends on basic research. Most such research in medicine is done in universities, the fountainhead of new knowledge. Yet the stark fact remains that basic medical research is not receiving proper support.

To give some idea of the state of medical research support in the United States today, I should like to cite a few figures. We are spending more than \$50 billion a year for defense. For research and development, we are spending about \$4 billion, of which only about 5 percent, or \$200 million, goes for medical research in its broadest terms. But only about \$80 million of this goes to support medical research in schools and universities, institutions in which most of the basic research is done, and this is supported about equally by the Federal Government and by universities and foundations.

If the federal contribution is, say, \$50 million a year, this would amount to only about 0.1 percent of what we spend for defense against an external enemy. We ought to consider whether we can afford to spend so little for defense against disease. Perhaps an incident from recent history will serve to illustrate the danger of inadequate research.

Many will remember the influenza epidemic in 1918, in which an estimated 150 million people had influenza and some 15 million died. The United States alone lost, in one 4-month period at the height of the epidemic, 400,000 people—a death toll about equal to our total deaths on the battlefield in the two world wars.

In 1918 the cause of influenza was unknown. It was not until 1931 that a lone investigator, Richard E. Shope, who was interested in an obscure disease of swine, discovered the first influenza virus and, thus, started the chain of events that today makes it possible to forestall another such catastrophe.

I do not argue for a decrease in defense spending but only for an increase in support of medical research. Nor, if I had a magic wand, would I increase support tenfold overnight, for the research people and the facilities needed for such an increase do not exist and would take several years to bring into being. What we need is to accept some desirable goal for basic medical research, say 1 percent of our national budget, and then to make a gradual and assured move toward that goal. "Contract" and "project" research will not fulfill our needs for basic research. There must be a marked increase in support with no strings attached for our "idea" men and women—that is, support for the person with ideas and not support for a project. No large numbers of people are involved; there are perhaps no more than 2000 senior investigators in basic medical research in this country. Surely 10 or 20 percent of these with ideas or of junior associates with ideas could be given the kind of support for research that is needed. Unrestricted support for our men and women with ideas would scarcely be noticeable in our economy and would bring incalculable benefits in health to millions who would otherwise suffer from disease.—WENDELL M. STANLEY, *University of California, Berkeley*.

This editorial is based on a speech given at a meeting of the American Foundation in New York, 15 Nov. 1955.



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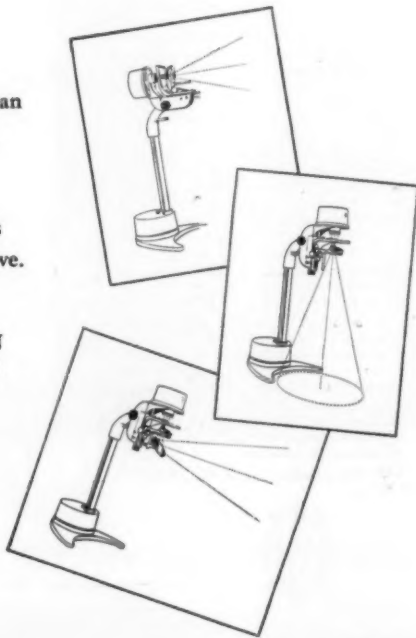
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## Absolute Chronology of the Last Glaciation

Hans E. Suess

Radiocarbon dating (1) has led to a well-established chronology of the Wisconsin stage of glaciation in North America, which was, until recently, considered to be equivalent to the Last or Würm Glaciation of Europe. The first step in this direction was the dating of wood from the Two Creeks forest bed in Wisconsin by W. F. Libby (2) which showed, contrary to what had been expected from other evidence such as telecorrelation of varve sequences, that the last major substage of the Wisconsin, the Mankato of North America, was equivalent to the Younger Dryas of Europe.

Since then, more than 60 individual measurements by Suess and by Rubin and Suess (3) at the U.S. Geological Survey in Washington, D.C., on samples from a large number of localities in North America have conclusively established the times of the next previous substages, the Cary and the Tazewell. The Tazewell substage represents, at least in the Middle West of the United States, the time of the maximum southward extent of the ice front, which was reached between 17,000 and 18,000 years ago after a more or less continuous advance over a period of more than 10,000 years (4, 5). The Washington radiocarbon dates are sufficiently conclusive to allow the calculation of rates of advance and retreat of the ice during that interval of time and thereafter (6, 8).

### Continental Glacial Chronology

At least four episodes of colder climate with advancing glaciers can be assumed

to have followed the Tazewell maximum with decreasing amplitude toward the present time. They are listed in Table 1 on page 356.

It appears that these oscillations have occurred at fairly regular intervals of about 3500 years. Various oscillations of still shorter periods can also be recognized. They seem to become increasingly conspicuous in postglacial time. For two pre-Tazewell substages of the Wisconsin, the Iowan and Farmdale, stratigraphic evidence and radiocarbon dates are less conclusive. Nevertheless, it seems conceivable that these episodes might represent such oscillations immediately preceding the Tazewell substage (8).

It can be shown, however, that the Wisconsin glacial stage of North America does not cover the whole period of the Last or Würm Glaciation as understood by European workers. Penck and Brückner (9) showed in 1909 that one can estimate from rates of weathering and deposition that the beginning of the Last Glaciation was about 100,000 years ago. Washington radiocarbon measurements also indicate that the last cold period must have begun much earlier than is indicated by the dates on wood from the early Wisconsin Farmdale loess deposits of Leighton (10) (samples W-68, W-69, W-79, W-141, and others). Interstadial forest zones in Canada and Alaska (W-100, 121, 157, 189, 76, 77, 174, and so forth) and the base of the interstadial Younger Loess II of Europe (W-173) as well as archeological remains from the Cold Mousterian were found to be older than the present range of the Washington laboratory, which is about 38,000 years.

### Deep-Sea Sediments

Further evidence for a long duration of the Last Glaciation comes from the study of deep-sea sediments. The composition of these sediments, in particular their carbonate content, depends strongly on climatic conditions. A series of climatic oscillations during the Pleistocene can be recognized. The extensive work of G. Arrhenius (11) on the titanium content of deep-sea sediments of the Pacific Ocean gives an estimated time for the beginning of the last cold period as 100,000 years ago; this agrees with the European estimates of Penck and Brückner. The technique involved determining the titanium sedimentation rate by radiocarbon dating of codeposited carbonate sediments (12).

A much more quantitative and direct approach was made by C. Emiliani (13), who applied Urey's paleotemperature method (14) to a large number of samples from various Atlantic and Caribbean cores. Emiliani identified and separated pelagic Foraminifera tests, usually *Globigerinoides sacculifera* and *Globigerinoides rubra*, from samples taken in 10-centimeter intervals along the cores. The  $O^{18}$  to  $O^{16}$  ratio in the  $CaCO_3$  of these tests was measured by the mass spectrometer group in Urey's laboratory (Toshiko Mayeda, Harmon Craig, and others) at the Enrico Fermi Institute for Nuclear Studies of the University of Chicago. As was shown by Urey (14), this ratio is essentially a function of the water temperature at the time of growth of the shells. In this way, the temperature of surface water was obtained as a function of depth below the top of each core.

The temperature records from all the cores show several regular oscillations. Emiliani finds an apparent amplitude of 7° to 8°C temperature variation. By taking into account a slight increase in the  $O^{18}$  concentration during glacial times, about 6°C actual variation of the mean temperature of the surface water is found at the locations where the cores were taken. The experiments and interpretation of the results are discussed in detail by Emiliani (13).

The author is a research geochemist at the Scripps Institution of Oceanography, La Jolla, California.

Table 1. Approximate time of maximum extent of glaciers in North America as determined from radiocarbon dates (4, 5).

Substage or advance	Time of max. extent before present (yr)	Pertinent samples
Post althothermal advance	3,000?	W-143, W-78
Cochrane	6,500 to 7,500	W-136, W-145
Mankato	10,000 to 11,000	W-42, W-83, W-49
Cary	13,500 to 14,500	W-198, W-33
Tazewell	17,000 to 18,000	W-187, W-165, W-91

Table 2. Apparent radiocarbon ages of carbonate from three deep sea cores determined at the U.S. Geological Survey (5, 6). The sedimentation rate for Core A 179-4 (from samples W-160 and W-159) was 2.78 cm/1000 yr or 1 cm/360 yr; the sedimentation rate for Core A 172-6 (from samples W-236 and W-247) was 3.70 cm/1000 yr or 1 cm/270 yr; the sedimentation rate for Core A 180-73 (from samples W-280 and W-278) was 2.44 cm/1000 yr or 1 cm/410 yr.

Sample No.	Depth (cm)	Material	Apparent age (yr)
Core A 179-4: lat. 16°36'N, long. 74°48'W, depth 2965 m (Caribbean Sea)			
W-160	0-10	Total carbonate	3,950 ± 250
W-158	23-30	Fine fraction	13,500 ± 400
W-159	23-30	Coarse fraction	11,800 ± 300
W-134	30-35	Total carbonate	15,700 ± 400
W-164	60-65	Total carbonate	21,300 ± 800
W-162	70-77	Coarse fraction	27,600 ± 1000
W-135	150-155	Total carbonate	35,000 ± 3000
W-147	260-265	Total carbonate	35,000 ± 3000
Core A 172-6: lat. 14°59'N, long. 68°51'W, depth 4160 m (Caribbean Sea)			
W-236	0-10	Coarse fraction	3,700 ± 200
W-237	51-61	Coarse fraction	17,500 ± 500
W-238	114-125	Coarse fraction	36,000 ± 3000
W-239	240-250	Coarse fraction	> 38,000
Core A 180-73: lat. 0°10'N, long. 23°0'W, depth 3749 m (Mid-Atlantic Ocean)			
W-280	0-8	Coarse fraction	2,960 ± 300
W-278	30-38	Coarse fraction	15,300 ± 300
W-276	80-88	Coarse fraction	27,000 ± 1500

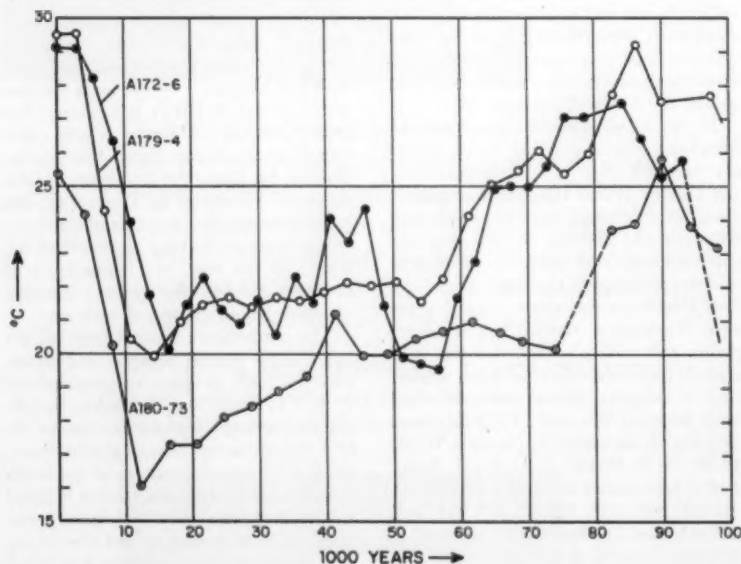


Fig. 1. Paleotemperatures of Foraminifera tests (*Globigerinoides sacculifera*) from  $O^{18}$  measurements at the University of Chicago (13) versus their age from  $C^{14}$  measurements at the U.S. Geological Survey (5, 6) for three deep-sea cores from the Lamont Geological Observatory, Palisades, New York.

Carbon-14 determinations were carried out at the U.S. Geological Survey radiocarbon laboratory on three of these cores (5, 6), which had been investigated for  $O^{18}$  by Emiliani, for the purpose of determining rates of deposition and, from this, the temperatures as a function of time.

The core material was supplied by D. Ericson of the Lamont Geological Observatory, who selected cores that appeared as homogeneous and as free as possible from the effects of turbidity currents, erosion, or slumping. The respective levels for  $C^{14}$  dating were selected by Emiliani on the basis of  $O^{18}$  trends.

Table 2 lists the results of these  $C^{14}$  measurements, expressed in terms of apparent ages, which were obtained by taking for present-day carbonate the  $C^{14}$  to  $C^{12}$  ratio of modern wood (15) and 5568 years for the  $C^{14}$  half-life (1). The true  $C^{14}$  to  $C^{12}$  ratios of modern sea carbonate are not accurately known, in particular with respect to possible geographic variations, but the uncertainty in the ages will, for this reason, not exceed a few hundred years. For two other reasons, the apparent ages may well deviate from the true ages to a considerably greater degree. (i) The core material may contain redeposited old carbonate incorporated in some way from stirred-up or dissolved older sediments. (ii) It may also contain some modern carbonate as a result of exchange with atmospheric  $CO_2$  during the handling and drying in the laboratory.

The statistical standard error of each measurement is given in the table. It expresses the uncertainty in the  $C^{14}$  determination only, and not the uncertainty in age that results from admixture of foreign carbonate. An indication of admixture of old carbonate can be seen from the fact that the total carbonate in the fine fraction has an apparent age sometimes greater by almost 2000 years than the coarse fraction, which consists mainly of Foraminifera tests. All considerations are based on measurements from sieved fractions (greater in size than 74 microns) prepared by Ericson at the Lamont Geological Observatory. The addition of old carbonate, provided that it was constant, only affects absolute age values and not the rates of deposition that are calculated from them. Addition of young carbonate, however, affects the older dates (greater than 20,000 years) to a much greater degree than younger ones. That such an addition has, in some instances, actually taken place can be seen from the measurements for samples W-135 and W-147. The age of these layers was undoubtedly much greater than the apparent age of 35,000 years. Such an addition is insignificant for younger dates (less than 20,000 years); the

younger dates were used for calculating rates of deposition.

In Fig. 1, the  $O^{18}$  temperatures (derived from *Globigerinoides sacculifera*) as determined at the University of Chicago are plotted as a function of age, which was obtained from the rate of deposition that results from  $C^{14}$  determinations at the U.S. Geological Survey. It was assumed that this rate was constant and equal to that at which the upper part of the cores was deposited. Despite the obvious uncertainties of this assumption, it can be seen that the temperature trends as a function of time in the three cores investigated so far agree surprisingly well. If the rate of deposition was different during glacial times from that during the more recent period, then this difference must have been nearly the same in the three cores.

Assuming that this difference was negligible, one finds that a period of decreasing temperatures began about 80,000 years ago. The temperature reached a minimum about 15,000 years ago; this time coincides within the accuracy of the method with the time of the maximum extent of the North American ice sheet. Thereafter, a relatively rapid temperature increase took place, leading to conditions resembling those of the present. Although no indications for fluctuations of a 3500-year period can be recognized, the record from the core material seems to parallel the continental glacial and postglacial events in a crude but unmistakable way. Extrapolating backward in time, we find that the record shows a less pronounced temperature minimum about 55,000 years ago that preceded a

relatively moderate period about 45,000 years before the present. The warm period of about 90,000 years ago may be correlated with the Sangamon time of North America, and the moderate period of 45,000 years ago may be correlated with a yet unnamed oscillation that is recognized in Pleistocene stratigraphy of the northern areas of North America (3). With respect to European glacial chronology, the sequence resembles that proposed by Zeuner (16) if one correlates the temperature interstadial of 45,000 years ago with LG 2/3 and the time about 85,000 years with LG 1/2. Such correlation with the respective Würm phases may well require revision. However, a certain similarity of the temperature record in the core material with the astronomical insolation curve of Milankovitch (17), on which Zeuner's chronology is based, cannot be denied. This, at least, is the conclusion that Emiliani (13) derives from the combined temperature records of his cores, which in some instances go back to the beginning of the Pleistocene, and from sedimentation rates estimated from various methods of dating. In particular, the 40,000-year period in the obliquity of the earth's axis (18) seems to be reflected in these records. The minima in the obliquity, however, precede the temperature minima by nearly 10,000 years.

### Summary

It appears that there is evidence for two main types of climatic fluctuations that have occurred during the Last Glaciation

on two different time scales, one of the order of 40,000 years and another of the order of 3500 years. The Last Glaciation embraces at least two of the long periods (Fig. 1) upon which are superimposed oscillations of the short period (Table 1). Apparent contradictions in radiocarbon dates (19) are at least in part the result of miscorrelations between events on these two different time scales (20).

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20. This article is a contribution from the Scripps Institution of Oceanography, new series, No. 843. Thanks are due to C. Emiliani for making his manuscript (13) available to me prior to its publication. The critical comments of R. Rex, M. Rubin, and C. Emiliani are appreciated.

bers of a conference. Meetings are held in the morning and in the evening, Monday through Friday, with the exception of Friday evening. The afternoons are available for recreation, reading, or participation in discussion groups as the individual desires. This type of meeting is a valuable means of disseminating information and ideas that otherwise would not be realized through the normal channels of publication and scientific meetings. In addition, scientists in related fields become acquainted, and valuable associations are formed that often result in collaboration and cooperative efforts between different laboratories.

It is hoped that each conference will extend the frontiers of science by fostering a free and informal exchange of

The author is director of the Gordon Research Conferences and head of the department of chemistry at the University of Rhode Island.

## Program of the Gordon Research Conferences

W. George Parks

The Gordon Research Conferences of the American Association for the Advancement of Science for 1956 will be held from 11 June to 31 August at Colby Junior College, New London, N. H.; New Hampton School, New Hampton, N. H.; and Kimball Union Academy, Meriden, N. H.

**Purpose.** The conferences were established to stimulate research in universities, research foundations, and industrial laboratories. This purpose is achieved by an informal type of meeting consisting of scheduled lectures and discussion groups. Sufficient time is available to stimulate informal discussions among the mem-



ideas among persons actively interested in the subjects under discussion. The purpose of the program is not to review the known fields of chemistry but primarily to bring experts up to date on the latest developments, to analyze the significance of these developments, and to provoke suggestions concerning the underlying theories and profitable methods of approach for making new progress.

In order to protect individual rights and to promote discussion, it is an established requirement of each conference that all information presented is not to be used without specific authorization of the individual making the contribution, whether in formal presentation or in discussion. Scientific publications are not prepared as emanating from the conferences.

**Registration and reservations.** Individuals interested in attending the conferences are requested to send their applications to the director on or before 1 April. Each applicant must state the institution or company with which he is associated and the type of work in which he is interested. Attendance at each conference is limited to 100.

The director will submit the names of those requesting attendance to the Conference Committee for each conference. This committee will review the names and select the members in an effort to distribute the attendance as widely as possible among the various institutions and laboratories represented. A registration card will be mailed to those selected as soon as possible. Advance registration by mail for each conference is required, and registration is completed on receipt of the card and a deposit of \$25 made payable to the Gordon Research Conferences, AAAS. The deposit of \$25 will cover the registration fee of \$20 and provide \$5 credit against subsistence expenses.

Academic individuals and others on personal expense may apply for a reduction of \$10 in the registration fee. Application for this special fee must be made when the registration card is returned.

The room rates are as follows: \$2.50 per night per person in a double room with single beds; \$3.00 per night per person in a single room; \$3.50 per night per person in a single or double room with private bath (the number of rooms available with bath is limited; assignments are made in the order that applications are received). Meals in the dining room are served at the rate of \$6.50 per day per person. Gratuities are provided for by an additional charge of 10 percent, which is added to each bill. Members attending a conference are expected to live at the conference location because the conferences are organized to provide a place for scientists to get to-

gether both formally and informally. It is to the advantage of all participants to attend a conference for the entire week. If special circumstances warrant living elsewhere, all individuals, including academic members, are required to pay a registration fee of \$25.

Accommodations are available for a limited number of women to attend each conference, also for wives who wish to accompany their husbands. All such requests should be made at the time of the request for attendance because these limited accommodations will be assigned in the order that specific requests are received. Children under 12 years of age cannot be accommodated. Dogs or other animals will not be permitted in the dormitories.

**Special fund.** A special fund from the registration fees is put at the disposal of the chairman of each conference by the Management Committee to assist scientists from academic and government institutions who cannot attend or participate because of financial limitations. This fund is provided with the object of increasing the participation of research workers of academic and government laboratories; it is limited to scientists who have been invited by the chairman to attend a conference in order to present a paper or because it is expected that they will make significant contributions during their stay at the conference. The money is to be used as an assistance fund only and may be used to contribute toward the traveling and/or subsistence expenses at the conference. Total travel and subsistence expenses normally will not be available.

**Cancellations.** The notice of cancellation must be received in the office of the director 3 weeks prior to the conference. If such notice is received 3 weeks in advance of the conference, \$20 will be refunded from the \$25 deposit. No refund will be made for cancellations received within the 3-week period.

**Attendance.** Requests for attendance at the conferences, or for any additional information, should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, R. I. From 10 June to 1 September, mail should be addressed to Colby Junior College, New London, N. H.

#### Colby Junior College

##### Catalysis

H. H. Voge, *chairman*

R. L. Burwell, Jr., *vice chairman*

11 June. R. L. Burwell, Jr., "The exchange reaction between alkanes and deuterium on heterogeneous catalysts"; G. M. Schwab, "New results on kinetics and nature of some catalytic reactions"; C. G. Overberger, "Polymerization catalysis by metal alkyls."

12 June. H. Pines, "New sodium-catalyzed reactions of hydrocarbons"; D. J. Berets, H. Clark, G. L. Simard, Mrs. G. C. Serreze, "Vanadium oxide catalysts—I, electrical properties, II, kinetics of o-xylene oxidation"; J. H. Singleton, "Hydrogen sorption and the parahydrogen conversion on evaporated nickel."

13 June. Karl Haufler, "Heterogeneous catalysis on semiconductor surfaces"; P. H. Miller, Jr., "Electron-transfer mechanisms at surfaces of semiconductors"; R. A. Alberty, "Mechanism and kinetics of enzyme catalysis"; D. A. Koshland, Jr., "Organic mechanisms in enzyme catalysis."

14 June. C. J. Plank, D. J. Sibbett, R. B. Smith, "Comparison of various catalysts in cracking pure hydrocarbons"; R. G. Haldeman, "Regeneration of cracking catalysts"; H. A. Benesi, "Acid strengths of catalyst surfaces from indicator colors"; T. J. Gray, "Defect nature of silica-alumina cracking catalysts."

15 June. G. Parravano, "The carbon monoxide-steam reaction on metal catalysts"; R. B. Anderson, J. F. Shultz and M. Abelson, "The influence of catalyst geometry on the rate of the Fischer-Trossch synthesis with reduced and nitrided iron catalysts."

##### Petroleum

John S. Ball, *chairman*

Lawrence H. Flett, *vice chairman*

18 June. H. S. Mosher, "Preparation and decomposition of hydroperoxides"; Guy Waddington, "Application of thermodynamics to petroleum problems."

19 June. *Some petroleum research fund investigations*, C. R. Wagner, *chairman*; Cheeves Walling, "Reactions of mercaptide radicals with hydrocarbons"; D. F. DeTar, "Aliphatic intramolecular chain transfer reactions"; W. O. Huntsman, "Double-bond migration and racemization of olefins during hydrogenation."

20 June. *Radiation of hydrocarbons*: H. A. Ohlgren, "The influence of radiation on thermal and catalytic cracking, hydroforming, alkylation, and petrochemical reactions"; R. O. Bolt, "Hydrocarbons as reactor-moderator coolants."

21 June. S. F. Birch, "Separation of sulfur compounds from petroleum"; *Gordon Conference Anniversary Program*, L. Flett, *chairman*; O. V. Tracy, "The fruits of petroleum chemistry."

22 June. R. B. Williams, "Applications of nuclear magnetic resonance to petroleum problems."

##### Separation and Purification

H. G. Cassidy, *chairman*

Karl Kammermeyer, *vice chairman*

25 June. Arthur Rose, "Logical evaluation of separation processes"; B. J.



Mair, "Fluorochemicals as an aid in separation methods."

26 June. G. J. Pierotti, C. H. Deal, E. L. Derr, "Molecular structural effects on solution behavior—implications in separation processes"; E. L. Mackor, "The basicity of aromatic molecules."

27 June. H. W. Patton, "Gas adsorption chromatography"; A. B. Littlewood, "Separative efficiency in gas partition chromatography"; L. C. McCabe, "Trace and unknown contaminants; air pollution."

28 June. R. M. Barrer, "Developments of the molecular sieve method of separation"; L. C. Craig, "Fractional dialysis and its relation to other separation techniques"; H. E. Kremers, "Separation and purification of the rare earths."

29 June. R. N. Hall, "The controlled addition of impurities to semiconductors."

### Polymers

C. G. Overberger, *chairman*

W. E. Cass, *vice chairman*

2 July. H. Mark, "Recent advances in polymer chemistry"; C. C. Price, "Polymerization of *dl* and *l*-propylene oxide"; H. N. Friedlander, "Role of organometallics in heterogeneous polymerization of ethylene"; K. Ziegler, subject to be announced; W. B. Reynolds, "Olefin polymers from the Phillips low pressure process."

3 July. G. Natta, "Isotactic polymers"; P. Giustiniani, "Production and properties of the new crystalline isotactic polymers"; F. P. Redding and E. R. Walter, "Some aspects of the crystallinity and related properties of high-density polyethylene and  $\alpha$ -olefin polymers."

4 July. C. Sadron, "Light scattering in solutions of electronically orientated macromolecules"; H. Boardman, "Penton—a new polyether derived from 3,3-bis (chloromethyloxetane)"; P. J. Flory, "Some aspects of crystallization of polymers."

5 July. F. S. Dainton, "Polymerization of acrylamide in aqueous solution"; J. W. Williams and K. Van Holde, "The theory and practice of sedimentation analysis"; J. H. Freeman, "Organic chemistry of the phenol-formaldehyde reaction."

6 July. C. F. Hammer and E. E. Lewis, "The molecular structure of polyethylene and its influence on the properties of melts"; R. G. Arnold, "Recent advances in isocyanate chemistry."

### Textiles

G. R. Seidel, *chairman*

H. A. Secrist, *vice chairman*

9 July. Wilson A. Reeves and William Weaver, "Some recent advances in the chemical transformation of cotton into new fibers"; G. J. M. Sprokel, "Electrostatic properties of finished cellulose acetate yarns."

10 July. Milton Harris and Robert Saxon, "Chemical modifications of wool as related to fiber properties"; L. G. Ray, "Textured filament yarns."

11 July. Herman Mark, "New polymers as potential fiber formers"; W. Weltzin, subject to be announced.

12 July. Stanley Backer, "Dimensional effects in measurement of textile properties"; Alfred Marzocchi and J. K. Park, "Glass textile sizes and finishes."

13 July. John Menkart, "Wool fiber shape factors: effect on fiber properties, processing behavior, and fabric properties."

### Corrosion

J. J. Harwood, *chairman*

W. R. Robertson, *vice chairman*

#### Kinetics and Mechanisms of Reactions

16 July. *Recent advances in electrochemistry*, N. Hackerman, *chairman*: R. Piontelli, "Electrochemistry of metals"; D. C. Grahame and I. R. Miller, "The adsorption of polyelectrolytes on a mercury surface"; A. J. Kolk, "Recent developments and current research in fused salt electrolysis"; J. E. B. Randles, "Mechanism of electrode reactions and related electrochemical phenomena."

17 July. *New researches in passivity*, M. Cohen, *chairman*: R. Speiser, "Some aspects of passivation"; H. H. Uhlig, "Passive films on iron"; M. Cohen, "Passivity of iron"; Panel session, "Mechanism of passivity."

18 July. *Nucleation of localized corrosion*, J. Petrocelli, *chairman*: P. M. Aziz, "The probability nature of pitting corrosion"; W. D. Robertson, "Structure-dependent nucleation of chemical reactions at metal surfaces"; M. A. Streicher, "Nucleation of corrosion in stainless steel"; Panel session, "Nucleation of corrosion reactions."

19 July. *Kinetics of corrosion reactions*, W. D. Robertson, *chairman*: A. J. deBethune, "Kinetics of heterogeneous reactions"; A. C. Makrides, "Some studies of the kinetics of corrosion reactions"; L. Epstein, "Corrosion by liquid metals"; W. D. Manly, "The phenomena of liquid-metal corrosion."

20 July. *Fundamentals of protective coatings—the "wash primer" system*, E. R. Allen, *chairman*: M. Bloom, "The mechanism of protective film formation"; F. Eirich and R. Ullman, "Polymer resins and their metal complexes in adsorption and adhesion."

### Instrumentation

Donald Williamson, *chairman*

Axel Peterson, *vice chairman*

23–27 July. Page S. Buckley, "Present and future control problems"; R. McKennell, "Recent developments in rheological instrumentation"; John Strong, "Academic courses for degrees in instrumentation"; Larkin Scott, "The application of simplified digital techniques to

certain data-handling problems"; R. L. Garman and S. W. Athey, "Application of television techniques to measurement and control"; John J. Grebe, "Instrumentation unlimited"; Warren S. McCulloch, "Human senses as instruments"; T. F. Hueter, "Sonic techniques in industry and science"; V. Salmon and J. S. Arnold, "The Stanford ultrasonic bond meter"; O. E. Orbom, "A proposal for the establishment of an automation laboratory"; Raymond Jonnard, "Internally referred photoelectric system for automatic interference recording"; James D. Hardy, "A gradiometer for the measurement of thermal conductivity of feathers and fur"; James D. Hardy, "A radiometer for measuring skin temperature during exposure to infrared radiation"; David H. Fuller, "Industrial vapor-phase chromatography"; E. W. Silvertooth, "Relative and absolute control of shaft speeds by digital techniques"; Nathaniel Brewer, "A continuous plant stream plasmometer for measurement of non-Newtonian viscosity"; T. K. Slawewski, "Low-cost two-dimensional heat-transfer analyzer"; H. Ziebolz, "Development of a purebred digital electrohydraulic servo system"; Elliot H. Woodhull, "Design of a liquid sample cell for infrared analyzers"; A. C. Hall and G. L. Knopf, "Experience with the Bendix time-of-flight mass spectrometer"; Marcus O'Day, "The dynamic use of the Seebeck effect for the direct conversion of heat into electric energy"; Robert J. Jeffries, "An instrumentation foundation?"; T. R. Vick Roy, "Precision pH control of nylon salt strike"; T. M. Dauphinee, "An instrument to measure the temperature of moving surfaces"; John F. Bishop, "Application of vapor-phase chromatography to continuous process control"; Ross D. Spangler, "A high-speed stress-strain machine"; Samir A. Haddad, "An application of differential amperometry."

### Elastomers

B. S. Biggs, *chairman*

E. E. Gruber, *vice chairman*

30 July. S. N. Muchnick, "Adhesive bonding of metals"; D. M. Alstadi, "Fundamentals of rubber adhesion"; S. M. Ohlberg and L. E. Alexander, "Crystallinity and orientation in organosiloxane polymers—x-ray diffraction studies"; E. L. Warrick, "Crystallinity and orientation in organosiloxane polymers—physical measurements."

31 July. G. Natta, "Synthesis by anionic polymerization of new elastomers and unsaturated crystalline polymers"; General discussion of synthesis and properties of *cis*-polyisoprene and related polymers; W. S. McNatt, "Biosynthesis of rubber."

1 Aug. R. M. Pierson, "Formation and properties of networks involving addition polymers having reactive end

groups"; H. Westlinning, "Interaction between rubbers and fillers"; G. Kraus, "The significance of swelling equilibria in carbon black reinforced elastomers."

2 Aug. J. W. Sellers, D. Inman, M. P. Wagner, "Reinforcement by fine particle silica"; I. Auerbach, W. C. Kuryla, S. D. Gehman, "A diffusivity approach for studying the molecular structure of elastomers"; L. Mullins, "Recent developments in theories of elastic behavior and mechanical failure of rubber."

3 Aug. K. W. Scott, "Dynamic properties of strained elastomers"; J. P. Berry, "Stress relaxation of natural rubber vulcanizates."

#### Food and Nutrition

Robert A. Harte, chairman

Harry Spector, vice chairman

6 Aug. *Atherosclerosis and nutrition*, Forrest E. Kendall, chairman: E. H. Ahrens, Jr., "Effects of dietary fats on serum lipides"; C. B. Anfinsen, Jr., topic to be announced. *New factors*, Lemuel D. Wright, chairman: speaker and topic to be announced.

7 Aug. *Trends in food habits and their nutritional implications*, Harry Spector, chairman: Hazel K. Stiebeling, "Food consumption of various income classes"; Bernard E. Proctor and Charles N. Frey, "Impact of advances in food technology"; O. V. Wells, "Analysis of the effects of farm surpluses and special food, distribution activities"; Robert L. Berg, "The nutritional problems of the allergic patient"; J. F. Muller, "Technologic aspects of special dietary food processing."

8 Aug. *Amino acids: Clarence P. Berg*, "Nutrition and metabolism of the  $\alpha$ -amino acids." *Relationship of nutrition to mental disturbances*, R. C. Ellingson, chairman: Max Horwitt, "Nutritional requirements in mental health"; Marvin Armstrong, "Studies on the relation of the biochemical defect to the development of the mental defect in phenylketonuria"; Donald B. Tower, "Amino acid metabolism in normal and epileptogenic cerebral cortex."

9 Aug. *Flavor*, Loren B. Sjostrom, chairman: Karl Pfaffmann, topic to be announced; Torsten Hasselstrom, "Food flavors." *Worldwide nutrition problems*, W. H. Sebrell, Jr., chairman: Robert R. Williams, "Food enrichment"; speaker to be announced, "Kwashiorkor."

10 Aug. *Eastern Utilization Research Branch activities*, R. A. Harte, chairman: R. K. Eskew, "Preparation of full-flavored fruit juice concentrates and powders"; W. G. Gordon, "Isolation and composition of the proteins of milk."

#### Vitamins and Metabolism

Karl Folkers, chairman

George W. Kidder, vice chairman

13 Aug. Robert S. Olson, "Coenzyme syntheses in various nutritional states";

Fritz Lynen, "The substitution of pantothenate in coenzyme A-dependent reactions"; I. C. Gunsalus, "Metabolic transformations of lipoic acid"; Paul Gyorgy, "Studies on the nutrition of human bifids"; William Shive, "Some biological effects of glutamine."

14 Aug. Clifford Shunk, "Studies on factor III and vitamin B<sub>12</sub>"; K. Bernhauer, "Synthesis and biosynthesis in the cobalamin series"; John White, "X-ray structural determination of vitamin B<sub>12</sub>"; Hellmuth Heinrich, "Vitamin B<sub>12</sub> metabolism under normal and pathological conditions"; J. R. Couch and T. M. Ferguson, "The histopathology of avian embryonic vitamin deficiencies—vitamin B<sub>12</sub> and vitamin E."

15 Aug. Esmond E. Snell, "Model reactions in studies of the metabolic role of vitamin B<sub>6</sub>"; Louis D. Greenberg, "Studies of vitamin B<sub>6</sub> and riboflavin deficiencies in the rhesus monkey"; James S. Dinning and Paul R. Day, "Nutritional muscular dystrophy in the monkey"; M. K. Horwitt, "Vitamin E requirements of man"; Robert S. Goodhart, "Nutrition surveys (i) evaluation of methods (ii) incidence malnutrition in Cuba."

16 Aug. Joel G. Flaks and John Buchanan, "Single carbon transfer reactions and purine biosyntheses"; Harry Broquist, "Some aspects of folic acid metabolism"; Charles A. Nichol, "Reduced derivatives of folic acid in leukemic cells"; Charles Gilvarg, "Biosynthesis of diaminopimelic acid by *E. Coli*"; Lemuel D. Wright, "The microbiology and isolation of a new growth factor"; Donald E. Wolf, "Chemical studies on a new growth factor."

17 Aug. H. J. Deuel, Jr., "Essential fatty acids in reproduction in the rat"; D. H. Laughland, "Studies related to a biochemical and physiological role of vitamin A"; Charles H. Hill, "Vitamins and disease resistance."

#### Medicinal Chemistry

Bernard B. Brodie, chairman

K. E. Hamlin, vice chairman

20 Aug. *Sleep*: Nathaniel Kleitman, "Physiology of sleep"; Seymour S. Kety, "Biochemistry of sleep"; Keith Wheeler, "The chemistry of new sedative and hypnotic drugs"; Louis Lasagna, "Clinical disorders of sleep."

21 Aug. *Skin*: Stephen Rothman, "Introductory remarks"; E. J. Van Scott, "Keratinization"; Stephen Rothman, "Sebum production"; Walter B. Shelley, "Physiology and pharmacology of pruritus"; J. H. Draize, "Percutaneous absorption"; Marion B. Sulzberger and Victor H. Witten, "Pharmacology of topical application."

22 Aug. *Drug action*: Nathan Kaplan, "A new concept in mechanism of drug

action"; Adrien Hogben, "Mechanisms of gastrointestinal absorption of drugs"; James Fouts, "Synergistic and potentiating mechanisms in drug action"; Speaker to be announced, "Interaction of drugs with receptor sites."

23 Aug. *Psychopharmacology*: Robert W. Hyde, "Present status of psychopharmacology from the clinical viewpoint"; Richard York, "Evaluation of psychopharmacological drugs in the clinic"; Arthur Riopelle, "Evaluation of psychopharmacological drugs in the monkey." *Clinical investigation*: Panel discussion, "Problems of clinical investigation of drugs," R. K. Richards, moderator: John J. Burns, A. H. Holland, Louis Lasagna, other panel members.

24 Aug. *Psychopharmacology*: Leonard Cook, "Evaluation of psychopharmacological drugs in the rat"; W. A. Wilson, "Central nervous system areas involved in the conditioned response"; Keith Killam, "Drug effects on the response to stimulation of specific central nervous system areas."

#### Cancer

H. S. N. Greene, chairman

Arthur Kirschbaum, vice chairman

27 Aug. W. Ray Bryan, "The problem of quantitative biological experimentation in the tumor-virus field"; Vincent Groupe, "The brain of newly-hatched chicks as host tissue for Rous sarcoma virus"; A. M. Prince, "The use of the chick embryo in quantitative studies of the Rous sarcoma virus"; Ludwig Gross, "Filterable agents causing leukemia, parotid gland tumors, and/or soft-tissue sarcomas following inoculation into newborn mice of susceptible strains."

28 Aug. J. W. Beard, "Etiology and interrelationships of the avian leukemias"; H. B. Andervont, "Recent studies on the milk factor"; J. T. Syvertson, "The pathogenesis of the rabbit papilloma to carcinoma sequence"; R. R. Wagner, "Interaction of influenza virus and tumor cells."

29 Aug. M. C. Nui, "Studies on embryonic induction"; S. M. Rose, "Differentiation and the tumor problem"; N. Kalis, "Limitations of the use of transplantable tumors in cancer research"; H. Toolan, "Embryonic skin homographs."

30 Aug. H. Busch, "Metabolism of radioactive plasma protein in tumor-bearing rats"; W. C. Hueper, "The role of environmental agents in human carcinogenesis"; H. Lisco, "Comparative studies on radiation carcinogenesis in man and animals"; B. S. Openheimer and I. Danishefsky, "Biological and chemical studies of the induction of malignant tumors by imbedding polymers."

31 Aug. P. Shubik, "Chemical carcinogenesis in chronic toxicity tests"; P. Kotin, "A mechanism for the pathogenesis of lung cancer."

## New Hampton School

### Organic Reactions and Processes

Robert B. Carlin, *chairman*

Harvey J. Taufen, *vice chairman*

11-15 June. G. Natta, "Isotactic polymers"; W. J. Bailey, "Pyrolysis of esters"; G. F. Hennion, "Acetylene chemistry"; W. E. Parham, "Heterocyclic compounds containing sulfur"; C. C. Price, "Dehydration of alcohols"; H. R. Guest, "Acrolein"; W. E. Hanford, "Fluorinated olefinic monomers"; R. I. Stirton, "Isophthalic acid"; H. J. Taufen, "Some terpene chemistry"; I. Wender and H. W. Sternberg, "The oxo process"; W. P. Utermohlen, Jr., "Preparation and some properties of aliphatic mercaptans"; R. T. Arnold, "Reactions of isobutylenes involving simple bond shifts."

### Metals at High Temperatures

V. N. Krivobok, *chairman*

18 June. *High-temperature deformation*, F. N. Rhines, *chairman*; J. Fisher, "Dislocation movements in creep deformation"; E. Parker, "Role of substructure on plastic properties"; W. Hibbard, *chairman*; E. S. Machlin and M. Abrahams, "Etch studies of dislocations in silver subjected to creep"; L. L. Marsh, "Creep deformation of single crystals."

19 June. G. J. Dienes, *chairman*; A. R. Chaudhuri, "Grain boundary deformation"; H. Brunner, "Strain across grain boundaries"; F. N. Rhines, "Third stage creep." *Fracture at elevated temperatures*, A. Focke, *chairman*; E. Perryman, "Fracture surfaces"; N. J. Grant, "Relationship between deformation and fracture"; B. Lazan, "Fracture in dynamic creep."

20 June. *Strength of materials*, N. J. Grant, *chairman*; W. Hibbard, "Solid solution strengthening"; F. Cuff, "Strengthening through cold work"; J. Freeman, "Hot working relationships"; R. Wilde, "Aging in high-temperature alloys." H. Young, *chairman*; F. H. Norton, "Strength of ceramics at elevated temperatures"; T. Shevlin, "Strength of cermets"; O. Preston, "The wrought-metal metal-oxide systems."

21 June. *High-temperature oxidation and surface reactions*, E. N. Skinner, *chairman*; K. F. Andrew, "High-temperature oxidation"; C. E. Birchenall, "The growth of oxides on metals and alloys"; A. Brasunas, "Accelerated oxidation"; G. P. Smith, "High temperature liquid corrosion." *General topics*, J. Frye, *chairman*; W. D. Manly, "Role of environment on creep performance"; P. Gordon, "Recrystallization"; P. Beck, "Abnormal grain growth."

22 June. B. Lazan, *chairman*; W. Beteridge, "Relaxation phenomena and fatigue"; A. Cochardt, "Damping in high-temperature materials"; L. F. Coffin,

"Thermal stresses, thermal stress fatigue, and thermal shock."

### Proteins and Nucleic Acids

George B. Brown, *chairman*

Christian B. Anfinsen, *vice chairman*

### Structural and Metabolic Interrelationships

25 June. H. Schachman, "Physical chemical studies on nucleic acids and nucleoproteins"; M. H. F. Wilkins, "Molecular structure of deoxyribose nucleoproteins"; A. Bendich and L. F. Cavalieri, "Properties of the DNA macromolecule"; G. L. Brown, "Chromatographic fractionation of nucleic acids"; E. Chargaff, P. Doty, A. Rich, D. Bradley, L. D. Hamilton, J. W. Rowen, M. Rosoff, C. Dekker, discussion.

26 June. C. F. Crampton, "Comparative studies on chromatographically purified histones"; A. E. Mirsky and V. Allfrey, "Nucleoprotein systems of the cell nucleus"; J. N. Davidson, "On metabolic relationships of nuclear and cytoplasmic nucleic acids"; A. Dounce, G. Schmidt, H. M. S. Smellie, W. H. Stein, S. Moore, J. L. Irvin, H. N. Munro, D. H. Marrian, discussion.

27 June. S. Spiegelman, "The roles of nucleic acids in protein synthesis"; E. T. Bolton, "Adsorption and incorporation of amino acids, purines and pyrimidines in microorganisms"; P. C. Zamecnik, "Studies on the role of RNA and nucleotides in protein synthesis"; G. C. Webster, "Some relationships of nucleotides to protein synthesis in cell-free extracts of plants"; S. Zamenhof, M. E. Balis, R. Roberts, F. Binkley, J. Strominger, J. E. Varner, M. L. Petermann, discussion.

28 June. W. M. Stanley, opening remarks; G. Schramm, "The constitution of the protein and the nucleic acid of TMV and their interaction"; H. Fraenkel-Conrat, "Reconstitution of active virus from protein and nucleic acid of different strains of TMV"; B. Compton, "Studies on the reactivation of tobacco mosaic virus fragments"; R. Markham, R. E. F. Matthews, W. F. Harrington, P. Newmark, G. Gamov, discussion; round-table discussion.

29 June. S. Ochoa, "Enzymatic synthesis of polynucleotides"; L. Heppel, "Enzymatic studies on ribonucleic acid and small polyribonucleotides"; V. Potter, F. Lipmann, E. Goldwasser, C. Heidelberger, M. Friedkin, E. Bennett, A. Kornberg, discussion.

### Coal

H. H. Storch, *chairman*

John Mitchell, *vice chairman*

2 July. R. A. Friedel, "Absorption spectra of coal and its degradation products"; I. G. C. Dryden and E. I. Doucette, discussion; H. C. Howard, D. W. van Krevelen, J. T. McCartney, "Struc-

tural significance of the physical properties of coal"; J. L. E. Hofer, S. Ergun, I. G. C. Dryden, discussion.

3 July. "Structural significance of the physical properties of coal" (continued); R. B. Anderson, D. W. van Krevelen, P. Fugassi, "Sorption of gases and liquids by coal."

4 July. I. Wender and M. B. Neuworth, "Organic chemical approaches to the structure of coal"; S. Freedman, S. Langer, S. Ergun, presentations and discussion.

5 July. M. Passer, R. S. Montgomery, H. B. Rickert, "Special analytical and separation procedures for coal and its degradation products"; W. C. Ellis, "Chemistry of low-temperature tar from lignite"; M. Rogoff, "Microbiological studies of coal."

6 July. Discussion of proposed new journal for fuel technology and of 1957 programs.

All sessions will be chiefly round-table discussions with a minimum of prepared presentations.

### Radiation Chemistry

Robert L. Platzman, *chairman*

C. J. Hochanadel, *vice chairman*

9 July. *Chemical utilization of nuclear energy*, Farrington Daniels, *chairman*; E. Rabinowitch, "Conversion of the energy of light into chemical free energy"; A. O. Allen, "Remarks on the potentialities of radiation chemistry for utilization of nuclear energy"; E. G. Linder, P. Rappaport, J. J. Loferski, "Direct conversion of radiation into electricity." *Interaction of radiation with solids*, L. H. Gray, *chairman*; R. K. Swank, "Emission of light by organic compounds under irradiation"; Ralph Livingston, "Paramagnetic resonance studies of free radicals in solids."

10 July. *Kinetics of radical reactions*, F. S. Dainton, "Rates of hydroxyl-radical reactions"; T. J. Hardwick, "Radical reaction rates applied to radiation chemistry." *The "free" electron in dipolar media*, L. Onsager, *chairman*; G. Stein, "Physical and chemical studies of the solvated electron"; W. K. Wilmarth, "Chemical evidence for the solvated electron."

11 July. *Radiation chemistry of aqueous systems I*, J. L. Magee, *chairman*; E. J. Hart, "Energy-dependence of the chemical yield by heavy ionizing particles"; N. Barr, "Energy-dependence of the chemical yield by heavy ionizing particles." *Radiation chemistry of aqueous systems II*, W. H. Hamill, *chairman*; F. S. Dainton, "Radiation-induced polymerization of acrylamide in dilute aqueous solution"; J. Ghormley, subject to be announced; L. I. Grossweiner, subject to be announced.

12 July. *Radiation chemistry of gases*: G. S. Hurst, "Ionization by alpha par-



ticles in mixtures of gases"; R. R. Williams, Jr., "Radiation chemistry of methane: ion-molecule reactions"; H. M. Rosenstock, subject to be announced; S. Thompson, subject to be announced. *Miscellaneous topics*, J. Ghormley, *chairman*: P. J. Dyne, "Some problems in dosimetry"; J. E. Willard, "Radiation chemistry of the alkyl halides"; T. F. Doumani, subject to be announced; D. J. Metz, subject to be announced.

13 July. *Radiation chemistry of polymers*, F. Hutchinson, *chairman*: M. Dole, "Melting properties of irradiated polyethylene"; A. A. Miller, "Crosslinking and degradation of polymers by irradiation."

#### Organic Coatings

Harry Burrell, *chairman*

E. G. Bobalek, *vice chairman*

16 July. Herman B. Wagner, "The statistical approach to coatings problems." Panel discussion: R. L. Hawkins, Jr., Mark P. Morse, W. Schickner, "Case histories of statistics applied in coatings."

17 July. W. K. Asbeck, "Adhesion of organic coatings to metal substrates"; G. G. Sward, "Adhesion of organic coatings to wood substrates."

18 July. E. H. Merz, "Microscopy of heterogeneous polymeric systems"; W. R. Moore, "Cellulose derivative-solvent interaction."

19 July. Henry Yuska, "Alkyd-amine resin interactions"; W. D. Coder, "Pentaerythritol reactions in coatings resins."

20 July. F. J. Modic, "Recent developments in silicone coatings."

#### Chemistry and Physics of Metals

Bruce Chalmers, *chairman*

B. L. Averbach, *vice chairman*

#### Equilibrium States of Metallic Systems

23-27 July. E. S. Machlin and A. S. Nowick, "Lattice vacancies in crystals"; E. A. Gulbransen and A. U. Seybolt, "Solid gas equilibria"; G. C. Kuczynski and B. E. Warren, "Order-disorder"; C. Wagner and L. S. Darken, "Liquid alloy equilibria"; O. K. Rice and A. Skapski, "Theory of liquids"; W. D. Robertson and R. B. Gordon, "Structure and properties of liquids"; R. A. Oriani and O. J. Kleppa, "Thermodynamics of solutions"; J. O'M. Bockris and R. Schuhmann, Jr., "Slag-metal equilibria"; A. D. Le Claire, subject to be announced.

#### Chemistry of Steroids and Related Natural Products

Josef Fried, *chairman*

E. J. Corey, *vice chairman*

30 July. E. E. Van Tamelen, subject to be announced; V. Boekelheide, "Some recent work on the chemistry of the erythrina alkaloids."

31 July. D. H. R. Barton, "The chemistry of columbin"; G. Büchi, "Structural

studies on some sesquiterpenes"; C. Djerassi, subject to be announced.

1 Aug. B. Bloom and E. Agnello, "Chemistry of ring D substituted corticoids"; R. B. Woodward, subject to be announced.

2 Aug. G. Stork, "A total synthesis of 11-oxygenated steroids"; K. Gerzon, "The chemistry of erythromycin."

3 Aug. S. Gurin, "Biosynthesis and catabolism of cholesterol."

#### Analytical Chemistry

W. D. Cooke, *chairman*

E. W. Balis, *vice chairman*

6 Aug. A. J. P. Martin, "Vapor-phase chromatography"; K. A. Krause, "Ion-exchange separations."

7 Aug. H. Frieser and G. H. Morrison, "Separation by extraction"; P. Delahay, "Electrochemical methods."

8 Aug. B. L. Vallee, "Flame spectroscopy."

9 Aug. E. L. Stanley, "The determination of traces of organic materials and residues"; open discussion session.

10 Aug. W. S. Horton, "X-ray fluorescence spectrometry."

#### Inorganic Chemistry

John F. Gall, *chairman*

Hans B. Jonassen, *vice chairman*

13 Aug. *Chemistry of the metal-carbon bond I*, John C. Bailar, *chairman*: speakers and subjects to be announced.

14 Aug. *Chemistry of the metal-carbon bond II*: speakers and subjects to be announced.

15 Aug. *The distant future of inorganic chemistry*: speakers and subjects to be announced.

16 Aug. *Solid-state chemistry I*, Roland Ward, *chairman*: speakers and subjects to be announced.

17 Aug. *Solid-state chemistry II*: speakers and subjects to be announced.

#### Statistics in Chemistry and Chemical Engineering

Lee Crump, *chairman*

20 Aug. W. J. Youden, *chairman*: Grant Wernimont, "The basis for interpreting results from a testing process." J. C. Whitwell, *chairman*: A. M. Dutton, "Statistics and experimentation."

21 Aug. R. J. Hader, *chairman*: S. L. Anderson, "Robust tests." C. W. Dunnnett, *chairman*: Paul N. Somerville, "Selecting the best from  $k$  populations."

22 Aug. J. S. Hunter, *chairman*: Paul Meier, "Sensitivity testing." Shelby A. Miller, *chairman*: Robert De Baun and F. Kutowicz, "Some examples of the use of statistics in industrial experimentation."

23 Aug. H. F. Smith, *chairman*: Jacob Horowitz, "What chemists and chemical engineers should know about time series." *Chairman to be announced*:

Ralph A. Bradley, "Recent research on statistical problems in subjective testing."

24 Aug. G. H. Symonds, *chairman*: Lionel Weiss, "Statistical decision theory."

#### Adhesion

Richard F. Blomquist, *chairman*

Don K. Rider, *vice chairman*

27 Aug. D. H. Kaelble and C. A. Dahlquist, "Analyses and mechanics of peel tests for adhesion"; N. A. deBruyne, "Recent studies on adhesion in England."

28 Aug. Robert L. Patrick, "Investigation of fundamental phenomena involved in adhesion"; M. H. Jellinek, "Carbofunctional silicones for chemical adhesion."

29 Aug. C. B. Norris, "Stress concentrations in adhesive-bonded joints"; K. F. Charter, "Curing and thermal stresses in resin-to-metal bonds."

30 Aug. R. A. Oriani, "Physics and chemistry of metals as applied to adhesion." Panel discussion: S. M. Muchnick, R. F. Blomquist, H. B. Linford, "Metal surface preparation for adhesive bonding."

31 Aug. *Polymer degradation and adhesion*. R. Simka, "I, Theory"; B. G. Achhammer, "II, Experimental."

#### Kimball Union Academy

#### Lipide Metabolism

E. H. Ahrens, *chairman*

Cecil Entenman, *vice chairman*

11 June. *Analytical*: Donald H. Wheeler, "Analytical methods for fatty acid composition"; S. L. Herb, "Micro-methods for determination of polyunsaturated fatty acids"; Klaus Hofmann, "Chromatography of fatty acids with emphasis on the separation of bacterial lipides"; Jules Hirsch, "Chromatographic separation of complex lipide classes with silicic acid"; Herbert J. Dutton, "Analysis of lipides by counter-current distribution."

12 June. *Fatty acid metabolism*: David E. Green, "Fatty acid oxidation and synthesis with purified enzyme systems"; Joseph R. Stern and George I. Drummond, "Enzymatic aspects of acetoacetate metabolism"; Minor J. Coon, "Enzymatic synthesis of  $\beta$ -hydroxy  $\beta$ -methylglutarate and other branched chain acids"; Priscilla Hele and George Popják, "Fatty acid synthesis in enzyme preparations of mammary gland"; Eugene P. Kennedy, "Enzymatic synthesis of phospholipides."

13 June. Donald J. Hanahan, "Incorporation of fatty acids into phospholipides"; Bengt Borgström, "Studies on pancreatic lipase"; Lewis I. Gidez, "Lipide metabolism in experimental

lipemia." *Essential fatty acids*: Ralph T. Holman and J. J. Peifer, "Functions of essential fatty acids"; Harry J. Deuel, Jr., "Interrelationships of cholesterol and essential fatty acid metabolism."

14 June. *Sterol metabolism*. Nancy Bucher, "Lipide synthesis in cellular fractions of rat liver"; Harry Rudney, "Biosynthesis of branched chain acids"; T. T. Tchen and K. Bloch, "The squalenecholesterol transformation"; Erwin Schwenk, "New experiments on the biosynthesis of cholesterol"; Ivan D. Frantz, Jr., "Possible late intermediates in cholesterol synthesis"; Ezra Staple and Sam Gurin, "Catabolism of the cholesterol side chain in *in vitro* systems."

15 June. Sune Bergström, "Quantitative aspects of sterol and bile acid metabolism"; Leon Hellman, "Isotopic studies of lipid and sterol metabolism in man"; George V. LeRoy, "Comparative studies of cholesterol metabolism in laboratory animals and man."

#### Stream Sanitation

Clair N. Sawyer, *chairman*

Leslie A. Chambers, *vice chairman*

#### Bases of Water Quality Criteria

18-19 June. *Requirements for human use*: M. Starr Nichols and Jules S. Cass, "Toxicological aspects"; Martin E. Flentje and A. A. Rosen, "Consumer acceptance"; Paul Kabler and W. L. Mallmann, "Microbiological aspects."

19-20 June. *Requirements of aquatic life*: Peter Doudoroff and John Cairns, Jr., "Fish and other vertebrates"; Charles E. Renn, "Invertebrates"; C. Mervin Palmer, "Phytoplankton and rooted aquatics."

20 June. *Requirements for agricultural uses*: L. V. Wilcox, "Irrigation"; Stuart G. Dunlop, "Stock raising and market produce."

21 June. *Requirements for industrial uses*: Eskel Nordell, "Food and beverage"; speaker to be announced, "Organic chemical"; Eskel Nordell, "Power"; C. Fred Gurnham, "Metallurgical and inorganic chemical."

22 June. *Integration*: Vinton W. Bacon and Leslie A. Chambers, "Interrelationships and multiple uses."

#### Nuclear Chemistry

L. Yaffe, *chairman*

E. K. Hyde, *vice chairman*

25-29 June. *The theoretical aspects and applications of the unified model of the nucleus. Geochemistry and cosmochemistry. Naturally occurring radioactivities (other than heavy elements). Low energy nuclear reactions. Absolute alpha and beta counting. Nuclear chemistry techniques. Experiments dealing with the antiproton. A report on various types of pulse-height analyzers.*

#### Chemistry and Physics of Isotopes

T. I. Taylor, *chairman*

Russell Baldock, *vice chairman*

2 July. *Isotope effects in spectroscopy including emission, infrared, microwave, mass and nuclear magnetic resonance*. J. Rand McNally, Jr., *chairman*: speakers and subjects to be announced.

3 July. *Determination of mechanisms from isotope effects on reaction rates*. Jacob Bigeleisen, *chairman*: Henry Taube; F. H. Westheimer; K. D. Wiberg; J. H. Wong; subjects to be announced. *Isotope effects on physical and chemical properties*: Jacob Bigeleisen; E. F. Hammel; A. S. Friedman; subjects to be announced.

4 July. *Isotope abundance measurements and isotope dilution analysis*. Russell Baldock, *chairman*: Russell Baldock, "Techniques of abundance measurements and isotope dilution analysis"; Leonard Herzog, "Application of isotope dilution"; L. O. Gilpatrick, "Determination of low concentrations of uranium by isotope dilution." *Isotopes in geology*, Earl Ingerson, *chairman*: T. S. Lovering, "Isotopes in geochemical exploration"; J. L. Kulp, "Recent developments in geochronology"; R. Wanless, "Mass spectrometric analyses by the Canadian Geological Survey"; George Wetherill, "Discordant lead-uranium ages."

5 July. *Methods of separating isotopes*. William Spindel, *chairman*: Klaus Clusius, "Separation of isotopes by thermal diffusion"; Alfred Klemm, "Isotope effects of ionic migration in fused salts"; William Spindel and T. I. Taylor, "Production of 99.9-percent nitrogen-15 by chemical exchange." Presentation of new data and discussions of current research activities.

6 July. *General topics in isotopes research*. Alfred P. Wolf, *chairman*: speakers and subjects to be announced.

#### Solid-State Studies in Ceramics

J. R. Johnson, *chairman*

H. O. Thurnauer, *vice chairman*

9 July. Gordon Finlay, "High-temperature materials"; Peter Gibbs, "Reaction rate theory in ceramics"; H. E. Kissinger, "Reaction kinetics in differential thermal analysis."

10 July. V. K. LaMer, "Nucleation"; F. C. Krack, "Polymorphism"; M. J. Buerger, "Silicate structures."

11 July. J. M. Warde and A. G. Tharp, "Determination of the geologic age of rocks by unit cell dimensional changes induced by radioactivity"; W. R. Foster, "Phase equilibrium approach to the problem of oil-ash corrosion"; R. W. Mooney, "Phosphors and fluorescence"; Rustum Roy, "Solid solubility and the distribution of solute ions between solid solvents."

12 July. W. D. Kingery, "Heat conduc-

tion in ceramics"; J. G. Cohn, "Solid-state reactions of special interest in ceramics." *Panel discussion on ferrites*. G. G. Palmer, *moderator*: F. E. Vinal and William Bauer, *panel members*.

13 July. Scott Anderson, "Infrared spectroscopy of glasses."

#### Chemistry, Physiology, and Structure of Bones and Teeth

R. F. Sognnaes, *chairman*

D. H. Copp, *vice chairman*

16 July. *Ground substance*. G. Wislocki, *chairman*: K. Meyer, "Chemistry of ground substance"; L. Belanger, "Histophysiology of chondroitin sulfate: synthesis turnover and potential role in mineralization"; D. W. Fawcett, *chairman*: S. Glasstone-Hughes, "Experimental studies in tooth development."

17 July. *The skeleton as an alkaline reserve*. W. Neuman, *chairman*: R. Bogoroch, P. Yeh, J. H. Shaw, R. F. Sognnaes, "Comparative studies on radiosodium turnover in bones and teeth of rats and rhesus monkeys"; W. Stoll, "Chemical studies on the nature of bone sodium"; G. B. Forbes, "The contribution of the skeleton in sodium homeostasis"; W. D. Armstrong, *chairman*: Y. Ericsson, "Solubility of calcium phosphate with special reference to the liquid-solid system of saliva, enamel, and tartar deposition."

18 July. *Citric acid and vitamin D*. M. Logan, *chairman*: L. Singer and W. D. Armstrong, "In vitro studies on uptake and turnover of citrate in calcified tissues"; M. S. Thompson and A. B. Hastings, "Factors affecting the citrate content of hydroxylapatite"; J. Crawford, D. Gribetz, W. Canada, P. Hurst, B. Castleman, "Influence of vitamin D on calcium and citrate metabolism in rats." P. E. Boyle, *chairman*: J. T. Irving, "A comparison of the influence of various dietary factors on the calcification sequences in enamel, dentin, and bone."

19 July. *Bone seekers*. R. Harris, *chairman*: J. C. Aub and W. B. Looney, "Long-term observations following administration of radium, lead, and thorium"; J. Jowsey, "Mechanism of yttrium, strontium, and sulfur deposition in bone"; H. Foreman, "Mode of plutonium and strontium combination with bone." F. C. McLean, *chairman*: B. Engelhardt, "Bone and tooth pathology investigated by microradiography and micro-interferometry."

20 July. *Round table discussion on the mechanism of calcification*. H. Hodge, *chairman*: R. S. Bear, "Structure of collagen"; W. F. Neuman, "The earliest events in calcification"; R. A. Robinson, "Crystal-water replacement during the calcification of osteoid"; A. E. Sobel, "The initiation of calcification."



## Chemistry at Interfaces

Willard M. Bright, *chairman*  
Charles G. Dodd, *vice chairman*

23 July. *Surface energies of solids*, Norman Hackerman, *chairman*; Stephen Brunauer, "Energies of ionic surfaces"; George Jura, "Surface and interfacial energy of molecular crystals"; J. G. Aston, "Adsorption of rare gases on heterogenous surfaces."

24 July. *Solid-solid interfaces*, Frank Healey, *chairman*: W. T. Read, "Dislocation theory of grain boundaries"; G. C. Kuczynski, "Mechanisms of sintering"; David Tabor, "Adhesion of clean metals"; D. G. Flom, "Friction and transfer in sliding contacts."

25 July. *Monolayers and films*, Hans Trurnit, *chairman*: L. S. Bartell, "Investigation of thin films by ellipsometry"; John Ross, "Adsorption of sodium dodecyl sulfate at air-liquid interfaces"; J. T. Davies, "Cohesion and charge effects in detergent films."

26 July. *Dispersed systems*, Charles G. Dodd, *chairman*: A. A. Bondi, "Properties of moderately-concentrated dispersions in oil"; J. W. Jordan, "Reactions of montmorillonite with organic cations"; John Turkevich, "Studies of colloidal gold."

27 July. *Round table discussion*, Donald Graham, *chairman*.

## Ion Exchange

H. C. Thomas, *chairman*  
W. J. Sloan, *vice chairman*

30 July. O. D. Bonner and G. E. Boyd, "Equilibria and thermodynamics"; R. F. Baddour and R. H. Bretton, "Kinetics."

31 July. M. R. J. Wyllie and M. J. Beran, "Flow in packed beds"; W. J. Sloan and A. A. Brooks, "Applications."

1 Aug. K. S. Spiegler and W. F. Graydon, "Membranes"; H. G. Cassidy and P. N. Craig, "Preparation of exchangers."

2 Aug. G. L. Gaines, "Inorganic exchangers"; H. F. Walton and E. C. Freiling, "Separations, cation exchange"; F. Nelson and A. Preuss, "Separations, anion exchange."

3 Aug. M. J. Hatch, "Ion retardation resins."

## High-Pressure Research

P. W. Bridgman, *honorary chairman*  
E. W. Comings, *chairman*  
H. G. Drickamer, *vice chairman*

6 Aug. *New techniques for high-pressure research*: L. Coes, "Mineral synthesis at high pressure"; G. Benedek, "Magnetic and nuclear resonance techniques at high temperature"; O. L. Anderson, "A new rapid high-pressure technique." *Solid mechanics*: E. A. Davis,

"Creep rupture tests on thick-walled cylinders."

7 Aug. *Chemical physics*: B. Vodar, "Electronic spectra at high pressure"; G. Benedek, "Nuclear resonance effects at high pressure"; M. F. Crawford, "Infrared and Raman spectra of compressed gases." *Properties of liquids and gases at high pressure*: B. F. Sage, subject to be announced.

8 Aug. *Solid-state physics*: A. W. Lawson, "Recent high-pressure research at the University of Chicago." *Pilot plant and industrial equipment*: speaker and subject to be announced.

9 Aug. *Detonation as a source of high pressure*: T. C. Poulter, subject to be announced. *Special topics in high pressure*: P. W. Bridgman, subject to be announced.

10 Aug. *Chemical processes and design*: speaker and topic to be announced.

## Toxicology and Safety Evaluations

Bernard L. Oser, *chairman*  
Norton Nelson, *vice chairman*

13 Aug. *Chronic animal studies*, Bernard L. Oser, *chairman*: Bert J. Vos, "The number of animals needed in toxicity tests"; J. M. Barnes, "Nature and elucidation of chronic toxic effects." *The biochemical approach*, Harold C. Hodge, *chairman*: R. T. Williams, "Chemical aspects of the metabolism of chlorinated hydrocarbons"; Hans Popper, "Toxic liver injury"; Bernard B. Brodie, "Pathways of drug metabolism."

14 Aug. *Inhalation toxicity*, V. K. Rowe, *chairman*: Joseph F. Treon, "Inhalation of vapors and gas"; Theodore F. Hatch, "Inhalation of dust, fumes, and aerosols." *Response of the skin to irritants and allergens*, David W. Fassett, *chairman*: Donald Birmingham, "Procedures for evaluating causative agents in contact dermatitis"; Herman N. Eisen, "Some chemical factors in contact dermatitis"; Thomas W. Tusing, discussion.

15 Aug. *Carcinogens*, John A. Zapp, *chairman*: O. G. Fitzhugh, "The design of chronic toxicity studies with particular reference to carcinogenicity"; Paul R. Cannon, "Dietary carcinogenesis"; Philippe Shubik, "Cocarcinogens." *Carcinogens (continued)*, Norton Nelson, *chairman*: Douglas M. Gay, "Cytological follow-up of workers exposed to bladder carcinogens"; Marvin Kushner, "Techniques for the evaluation of possible lung carcinogens."

16 Aug. *Nonmammalian toxicity and in vitro techniques*, Horace W. Gerarde, *chairman*: C. M. Pomerat, "Evaluation of chemical toxicity with tissue culture techniques"; Peter Doudoroff, "Principles and problems of fish toxicity." *Sociological and public health aspects*, Don D. Irish, *chairman*: Bernard L. Oser,

"Social implications and responsibilities pertaining to safety evaluations"; Wayland J. Hayes, subject to be announced.

17 Aug. *Special classes of potential toxicants*, Henry F. Smyth, *chairman*: Frank R. Blood, "Are special studies needed for surface active agents"; Thomas W. Tusing, "Special problems of cholinesterase inhibitors."

## Infrared Spectroscopy

E. R. Blout, *chairman*  
G. B. B. M. Sutherland, *vice chairman*

20 Aug. *Introduction and general theory*, R. C. Lord, *chairman*: J. Van Kranendonk; E. B. Wilson, Jr.; M. K. Wilson; R. C. Lord; subjects to be announced.

21 Aug. *Gases*, G. B. B. M. Sutherland and F. A. Miller, *chairmen*: H. L. Welsh; B. L. Crawford, Jr.; B. Vodar; subjects to be announced.

22 Aug. *Liquids and solutions, with special emphasis on hydrogen bonding*, E. R. Blout, *chairman*: R. S. Halford; G. M. Barrow; G. C. Pimentel; E. R. Lippincott; subjects to be announced.

23 Aug. *Solids*, R. S. Halford, *chairman*: R. M. Hexter; D. F. Hornig; H. H. Günthard; C. Haas; R. Mecke; H. W. Thompson; W. C. Price; N. R. Shepard; subjects to be announced.

24 Aug. *Intermolecular effects in empirical molecular structural analysis*, N. Wright and V. Z. Williams, *chairmen*: W. J. Potts; N. B. Colthup; subjects to be announced.

## Glass

F. W. Preston, *honorary chairman*  
O. L. Anderson, *chairman*  
T. H. Davies, *vice chairman*

*Strength, Fracture, and Surfaces*

27 Aug. General introduction: F. W. Preston, subject to be announced; speaker to be announced, "Report on International Congress on Glass." *Time and temperature effects*, E. B. Shand, *chairman*: T. C. Baker, "Strength dependence on temperature"; G. S. Horsley, "Unpublished results on static fatigue out to 2 years."

28 Aug. *High breaking strength*, G. R. Machlan, *chairman*: W. H. Otto, "Properties of high-strength fibers"; R. M. Witucki, "Report on high-strength bulk glass"; O. C. Hansen, "Report on high-strength fibers." *Classical view on strength*, J. E. Burke, *chairman*: E. Orowan, "Critique of Griffith flaw theory"; Speaker to be announced, "The size effect on flaw distribution."

29 Aug. *Flaws and their detection*, S. Bateson, *chairman*: W. R. Prindle, "Surface flaws by the electron microscope"; M. B. Hogan, "Stress concentrators"; M. Hirata, "Growth of rapid fracture"; *Fracture diagnosis*, L. G. Ghering,

chairman; E. F. Poncelet, "Fracture propagation"; H. Kolsky, "High speed photography."

30 Aug. *Surfaces*, J. W. Michener, chairman; E. U. Condon, subject to be

announced; W. F. Koehler, "Geometry of glass surfaces." *Surfaces*, H. E. Simpson, chairman; speaker to be announced, "Chemical reactivity of glass surfaces; the use of tracers."

31 Aug. Speaker to be announced, "Ionic diffusion in surface domain"; speaker to be announced, "Coupling of protective films and organic films to glass."

## Graham Edgar, Chemist of Parts

First as a youthful university professor and then as a creative industrial chemist and a capable executive, Graham Edgar led a full life and will be remembered in many ways. Nevertheless, his principal contribution—like that of many another modest research worker and teacher—has gone largely unrecognized. Those few in a position to know say that Edgar's discovery and preparation of isooctane and his missionary work with the engineers in the U.S. Air Force were directly responsible for the early development of 100-octane aviation gasoline. This fuel was an important factor in winning the Battle of Britain and in the subsequent Allied superiority in the air during World War II.

Born in Fayetteville, Arkansas, on 19 September 1887, Edgar grew up in an era when education was obtained with an economy of time and money that is unknown today. Before he was 22 he had joined the faculty of the University of Virginia, with a B.S. degree from the University of Kentucky and a Ph.D. in chemistry from Yale. He was a member of Phi Beta Kappa, Sigma Xi, and Tau Beta Pi. His initial research was in the sternly disciplinary field of analytic chemistry; his later work covered a wide range in both physical and organic chemistry. The abstractor of his first papers foreshadowed the character of all of Edgar's research when he said, "The method is very accurate . . . with excellent results obtained thereby."

Edgar taught at Virginia for 15 years, with an interlude during World War I. His wartime service included research at California Institute of Technology and

work for the National Research Council and the Ordnance Department, notably in the Fixed Nitrogen Laboratory. Indeed, his first patent, which he obtained during this period, related to the manufacture of fertilizer. The appropriateness of a pedagogue's contributing to this particular art always tickled Edgar's lively wit!

As a teacher, Edgar is remembered by his students with both affection and awe. Apart from his teaching, his major contribution to education was the chapter on "Homogeneous equilibria" in Taylor's classic, *Treatise on Physical Chemistry*. It was characteristic of Edgar that this work was published, not independently, but as part of a cooperative project.

Up to this point, Edgar's career had followed a conventional course. But he himself was innately a pathfinder, not a follower. When the opportunity came, he had the courage to leave the security of the university and turn to the exploration of new territory in industry. In June 1924, he joined the General Motors Chemical Company to help in the development of an infant industry: the use of tetraethyl lead as an antiknock for gasoline. Thus, in August 1924, he was one of the original staff of the then-named Ethyl Gasoline Corporation.

That industry was a far from healthy infant, and its survival was the result in no small part of Edgar's care. Working with only a handful of employees and with the most primitive facilities, he carried out both pure and applied research of significant importance. In 1925, on the basis of an inspiration of Thomas Midgley's, Edgar suggested and tested the first

workable method for recovering bromine from sea water. In 1926, he made the first synthesis of the branched-chain hydrocarbon known as isooctane, discovered its unexpected antiknock value, developed a method for its manufacture, and produced it in pilot-plant quantities. He obtained the companion straight-chain hydrocarbon, *n*-heptane, from a surprising source: the oil of the Jeffrey pine that grows in California. On the basis of his work with these two compounds, Edgar in 1927 established the octane-number scale that is still in use for determining the antiknock quality of gasoline.

He then synthesized all the nine isomeric heptanes in high purity and, with the participation of specialists in a number of university laboratories and the National Bureau of Standards, determined their important physical properties, thereby setting the pattern for the type of cooperative program that was later employed with such success by the American Petroleum Institute and other groups. This was followed by pioneer research in the slow oxidation of different hydrocarbons and the development of the theory of fuel knock and antiknock action. At the same time, Edgar perforce had many practical problems, which he handled with expedition and acumen.

Later years found him increasingly occupied with matters of his company's policy and management, but he kept a guiding hand on its research program. In September 1952, at age 65, he was retired as vice president of Ethyl Corporation and Ethyl-Dow Chemical Company; however, as a consultant, he remained active in the corporation's affairs. Although smitten with leukemia early last year, he persevered and was still working on his final publication shortly before his death on 8 September 1955.

Today, many of us are better chemists—and citizens—for having come under the influence of Graham Edgar's personality. We enjoyed the fruits of his wide learning, ready wit, and gusto for the good things in life; and we came away with respect for his candor, his integrity, his contempt for pretense in any form, and his abiding courage to speak out for his convictions. He set us a good example.

HAROLD A. BEATTY  
Ethyl Corporation, Detroit, Michigan

## News of Science

### Suprasternal Ossicles

Over the years, the supposed anatomical peculiarities of man among the primates, such as the extensor pollicis brevis and peroneus tertius muscles, the genial tubercles, the styloid process, and the appearance of cervical ribs, have disappeared one by one. For some of these spurious human distinctions have been found in other living primates, sometimes as unusual occurrences, sometimes in moderate frequency. Now another once-supposed human peculiarity, the presence of suprasternal ossicles, has been found to be more widespread in the order Primates than was once thought.

Ossicles located at the upper border of the manubrium at the sides of the interclavicular notch are not normal structures in man, but they are by no means rare. Cobb [*J. Anat.* 71, 245 (1937)], who regarded such ossicles as rudimentary homologs of the epicoracoids of the primitive vertebrate shoulder girdle, found them in 6.8 percent of 544 adult white Americans and in 2.2 percent of 466 adult American Negroes. He did not find a single ossicle, however, in the great-ape series of 61 gorillas, 38 chimpanzees, and eight orang-utans that he examined. Following Cobb's comprehensive study, the general belief seems to have prevailed that man was the only primate in which such ossicles had been found.

There seems little doubt, however, according to data gathered by Cobb from the literature, that ossa suprasternalia or their definite homologs had already been noted in several other primate genera, namely, a great ape (orang-utan), an Old World monkey (*Cercopithecus*), a New World monkey (*Alouatta*), and the tarsier. In 1944, Schultz [*Am. J. Phys. Anthropol.* n.s. 2, 1 (1944)] recorded the presence of separate suprasternal ossicles in two (=0.7 percent) of the gibbons that he examined. Recently, the occurrence of similar ossicles has been reported by G. T. Ashley [*Nature* 176, 608 (24 Sept. 1955)] in one chimpanzee (of 101 studied) and one gorilla (of 110 studied), and by D. V. Davies [*Nature* 176, 1130 (10 Dec. 1955)] in a lorissine lemur (*Perodicticus*).

Thus, distinct ossa suprasternalia, or their homologs, have now been found in representatives of all the living suborders of Primates, namely, in Lemuroidea, Tarsiodea, and Pithecoidea. For the last suborder, moreover, their presence has been recorded in all of the major groups—New World monkeys, Old World monkeys, anthropoid apes, and man. The seeming rarity of these ossicles in primates, as with cervical ribs, can probably be attributed to the fact that, being small, they can easily be lost during preparation of a skeleton.—W.L.S., Jr.

### G.E. Gas Turbine Division

On 9 Feb. the General Electric Company conducted a special tour of its Aircraft Gas Turbine Division in Evendale, Ohio, for industrialists and civil and military authorities. The division, which is headed by J. S. Parker, is valued at \$100 million dollars. The visitors were shown the company's new \$650,000 building, probably the first building in American industry especially designed to house computing equipment. By June, the second of two IBM 704 machines will have been installed. The IBM 704 has an 8192-word "memory"; it can execute 70 percent of its internal operations at the rate of 41,700 per second, and can make about 10,000 arithmetical operations a second while automatically keeping track of the decimal point.

Although more than half of the company's present investment in the division is exclusively in research, development, and test facilities, a \$20 million supersonic test unit is being planned and is expected to be completed in 1958. In announcing the new facility, Parker stated that it would be able to "simulate the same conditions a large jet engine would encounter flying at 2300 miles per hour, or three and a half times the speed of sound at 60,000 feet."

At present the Aircraft Gas Turbine Division develops aircraft propulsion systems, including turbojet engines, rocket motors, new types of gas turbine engines, combinations of these power plants, and other units. The division is also conducting basic research in high-

energy fuels, metals, and scores of other subjects pertinent to its business. Some 2000 technical people are engaged in this work. Parker pointed out that the new J79 engine is one of the division's major developments. Since 1948, G.E. has produced 30,000 turbojet engines; many more thousands have been produced by other manufacturers from the company's basic designs.

### WHO and Nuclear Energy

The executive board of the World Health Organization has unanimously endorsed a comprehensive program of research and study for protection against the effects of nuclear radiation. Included will be studies under WHO auspices on the effect of radiation on human heredity, the protection of health against radiation, the standardization of radiation units and radiation doses to encourage the adoption of uniform codes of practice, and the improvement of pharmaceutical standards for radioisotopes for medical use.

This action was one of the principal decisions taken by the board in the course of its seventeenth session, which concluded on 2 Feb. at Geneva. The recommendations of the board will be submitted to the next World Health Assembly, which is scheduled to open in Geneva on 8 May.

WHO work in the nuclear field, according to the plan approved by the board, will also include the training of health personnel, the provision of fellowships and training facilities for a study of the problem of radioactive waste disposal, and the collection and distribution of information on the medical problems of nuclear energy and on the medical uses of radioisotopes.

### News Briefs

■ The Atomic Energy Commission has opened a document room where records relating to the licensing program administered by the commission's Division of Civilian Application may be examined. The document room is located in the AEC building at 1717 H St. NW, Washington, D.C. Except for classified material and material for which "business confidential" treatment has been asked, the document room file will contain records of license and access permit applications and issuances, comments from interested persons on proposed regulations, and records of licensing hearings.

■ Harold E. Edgerton of Massachusetts Institute of Technology has developed an undersea camera capable of with-



standing pressures greater than those at the greatest known ocean depth. The camera was tested for the National Geographic Society, which has sponsored research on the instrument. Edgerton also has tested successfully a braided nylon line for lowering the 100-pound camera and electronic lights.

■ A new clotting factor in human blood, factor X, has been discovered by Francois Duckert, P. Fluckinger, and Fritz Koller of the University of Zurich, Zurich, Switzerland. It is considered significant that patients with the two liver diseases, hepatitis and cirrhosis, have blood deficient in the newly found factor.

■ Discovery of a strain of mice with hereditary muscular dystrophy has been announced by the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me. Although diseases arising primarily in striated muscle have frequently been found in human beings, spontaneous diseases of muscle appear to be very rare in experimental animals. This newly reported mutation in mice is apparently the first recorded instance of primary pathological involvement of muscular tissue in an experimental animal of known genetic background: Ann M. Michelson, Elizabeth S. Russell, and Pinckney J. Harman describe the work in a paper that appeared in a recent issue of the *Proceedings of the National Academy of Sciences*.

■ A bank of antisera to be used in identifying major virus diseases that attack cereal crops is being built by the U.S. Department of Agriculture and cooperating research groups at the Nebraska Experiment Station in Lincoln. Rabbits are being used in this bank as living sources of antibodies. With these antibodies, tests can be made to determine the presence of barley-stripe mosaic, brome-mosaic virus, and other similar diseases that cause heavy losses to growers of small grain in this country each year. This method of virus identification will speed up breeding for resistance to disease because it will enable breeders to rid stock of infected material before the plants have matured.

■ The shoreline at Point Barrow, Alaska, is receding southward at a rate of about 7 feet a year. It is probable that the land extended at least 500 feet farther north 75 years ago, an assumption borne out by the disappearance of a recorded Eskimo village. According to G. E. MacGinitie of California Institute of Technology in a report published recently by the Smithsonian Institution, the recession is caused by very low land and by ocean currents and wind tides that

sweep northeastward. MacGinitie was director for a year at the Navy's Arctic Research Laboratory at Point Barrow.

■ Rolls Royce, Ltd., London, England, disclosed on 10 Feb. that it had been working for 18 months to develop an atomic airplane engine. A spokesman would not predict when such an engine might be tested. A nuclear research laboratory devoted exclusively to light-engine research will be put in operation by Rolls-Royce within 2 months.

■ The median starting salary for chemists and chemical engineers with the bachelor's degree in the Delaware Valley area has reached a record high of \$390 a month, according to B. R. Stanerson, assistant secretary of the American Chemical Society. On 16 Feb. he reported at the society's first Delaware Valley regional meeting that the chemist who is being graduated from college this year can look forward to a starting salary some 16 percent higher than the \$335 rate that prevailed 4 years ago. The median starting figures for persons with master's and doctor's degrees are \$450 and \$590, respectively, also an increase of approximately 16 percent over the comparable 1952 rates.

#### Scientists in the News

JAMES BRYANT CONANT, chemist and president of Harvard University who is now U.S. Ambassador to the Federal Republic of Germany, has been chosen to receive the American Chemical Society's Charles Lathrop Parsons award for outstanding public service. The award, which cannot be given more frequently than once every 3 years, consists of a scroll and the privilege of choosing the recipient of a \$2000 scholarship for graduate study in chemistry, chemical engineering, or some related field. Presentation of the award to Conant will be made at a ceremony in Columbus, Ohio, during a meeting of the ACS board there next June.

JACQUES OUDIN, immunochemist at the Pasteur Institute, Paris, France, has completed a 3-month appointment as visiting scientist in the Laboratory of Biochemistry of the National Cancer Institute, Bethesda, Md. He has been invited to visit and lecture at a number of laboratories in the United States and Canada.

F. S. SPRING of the Royal Technical College, Glasgow, Scotland, will deliver the final lecture of Wayne University's "Frontiers in Chemistry" series on 23 Apr. when he will discuss "Some triterpenoid studies."

CLAUDE E. SHANNON, research mathematician at the Bell Telephone Laboratories, Murray Hill, N.J., has been appointed visiting professor of electrical communications at the Massachusetts Institute of Technology. While at M.I.T. during the spring term, Shannon will continue as an active member of the Bell staff.

MILDRED TROTTER, professor of gross anatomy at Washington University, was honored as one of the ten "Women of Achievement" in St. Louis, Mo., by the *St. Louis Globe-Democrat* for work as a physical anthropologist. Last spring Trotter was elected president of the American Association of Physical Anthropologists, the first woman to hold this office.

CONSTANTINE J. ALEXOPOULOS, professor of botany at Michigan State University, will resign in June to become professor and head of the department of botany at the State University of Iowa.

RODERICK MURRAY, deputy director of the division of biological standards at the National Institute of Health, has been appointed director. CARL L. LARSON, who has been acting director since the division was established in June 1955, will return to his former duties as director of the Public Health Service's Rocky Mountain Laboratory, Hamilton, Mont.

MACFARLANE BURNET of Melbourne, Australia, delivered the 1956 annual John Wyckoff lecture at the New York University College of Medicine on 28 Feb. Burnet, a well-known immunologist and virologist, is director of the Walter and Eliza Hall Institute of Medical Research and professor of experimental medicine at the University of Melbourne.

PAUL SCHWARZKOPF, president of the Schwarzkopf Development Corporation, the American Electro Metal Corporation, and the Metallwerk Plansee in Reutte, Tyrol, Austria, has received the Wilhelm Exner medal, one of Austria's highest decorations in the field of technical science.

SIDNEY R. ELSDEN is serving until 15 Aug. as visiting professor in the department of bacteriology at the University of Illinois, Urbana. He is senior lecturer in charge of the department of microbiology at Sheffield University, England, and honorary director of the Agricultural Research Council's Unit of Microbiology. During his stay at Illinois, Elsdon will give a series of lectures in microbial metabolism.



MARIO STEFANINI, a specialist in hematology, is the director of Joseph Stanton Memorial Research Laboratories, which were recently opened at Saint Elizabeth's Hospital in Boston, Mass. He will directly supervise research in blood. ROBERT SPELLMAN has been appointed to supervise surgical research. The \$500,000 laboratories will offer facilities for research to members of the visiting and resident staffs, as well as to medical students from Tufts University School of Medicine.

MARTIN A. ELLIOTT, research professor at Illinois Institute of Technology, has been appointed director of the Institute of Gas Technology. The institute, education and research facility of the nation's gas utility industry, is affiliated with I.I.T. and has headquarters at the I.I.T. Technology Center. The gas institute's staff of 62 scientists and technicians provide specialized education for present and future employees of the industry and perform research relating to the production, transmission, distribution, and utilization of natural and manufactured gas.

ERNEST C. HERRMANN, JR., formerly head of the virus laboratory of E. R. Squibb and Sons, and a research associate in the Institute of Microbiology at Rutgers University, has been appointed chief of the newly established virology and tissue culture section of the Schering Corporation's biochemical research department in Bloomfield, N.J.

EDGAR A. POST, former superintendent of navigational aids for United Air Lines, has been appointed manager of the radio systems laboratory at Stanford Research Institute. He will supervise the engineering division's research in electronic communication and navigation equipment and direct the studies in systems engineering.

MORRIS F. KETAY, an electrical engineer and president of the Norden-Ketay Corporation, has received the Cooper Union Alumni Association's Gano Dunn medal for outstanding professional achievement.

J. P. MCKENZIE, technical director of the Copolymer Rubber and Chemical Corporation, Baton Rouge, La., and J. D. SUTHERLAND, a chemical engineer in the company's research and development division, are winners of the Best Paper award of the American Chemical Society's Division of Rubber Chemistry for their paper, "A glass polymerization vessel for small-scale laboratory studies," which described an apparatus made from a standard industrial electric light globe.

## Recent Deaths

THOMAS D. ALLEN, Evanston, Ill.; 67; associate clinical professor of ophthalmology at the University of Illinois; 14 Feb.

ROBERT S. BREED, Geneva, N.Y.; 78; internationally known authority on dairy bacteriology and professor emeritus of bacteriology at Cornell University; 10 Feb.

J. HOWARD BROWN, Baltimore, Md.; 71; professor emeritus of bacteriology at Johns Hopkins Medical School; 9 Feb.

WARNER BROWN, Berkeley, Calif.; 73; professor emeritus of psychology at the University of California, Berkeley; 3 Feb.

A. BURTON COHEN, East Orange, N.J.; 73; consulting engineer; 12 Feb.

EMMETT DUNN, Haverford, Pa.; 61; professor of biology at Haverford College; internationally known herpetologist; 13 Feb.

HENRY P. GAGE, Corning, N.Y.; 69; retired head of the Corning Glass Works optical laboratory; 9 Feb.

ERNST A. HAUSER, Cambridge, Mass.; 59; professor of chemistry at Massachusetts Institute of Technology; 10 Feb.

G. MORTON ILLMAN, Philadelphia, Pa.; 78; associate professor of medicine at Temple University; 12 Feb.

JULIUS A. KOCH, Ocala, Fla.; 91; dean emeritus of the Pittsburgh College of Pharmacy; 10 Feb.

JOSEPH LE PRINCE, Memphis, Tenn.; 83; sanitary engineer who aided Gorgas to combat malaria and yellow fever during the construction of the Panama Canal; 10 Feb.

FRED MULLER, Saint Petersburg, Fla.; 65; electrical engineer; 6 Feb.

CORNELIUS L. SHEAR, Monroe, La.; 90; plant pathologist; 2 Feb.

KURT G. STERN, New York, N.Y.; internationally known biochemist; 3 Feb.

MICHAEL STREITCHER, Chicago, Ill.; 58; associate professor of medicine at the University of Illinois; 9 Feb.

WALTER TIMME, Saint Petersburg, Fla.; 81; first professor of neuroendocrinology at the College of Physicians and Surgeons of Columbia University; 12 Feb.

ESTHER G. UHRBROCK, Cincinnati, Ohio; 62; psychologist; 11 Feb.

ROBERT WIDMER, Hawthorne, N.J.; 69; retired textile chemist; 10 Feb.

NATHANIEL W. WINKELMAN, SR., Philadelphia, Pa.; 64; professor of neuropathology at the University of Pennsylvania; 13 Feb.

ROBERT M. YERKES, New Haven, Conn.; 79; professor emeritus of psychology at Yale University; originator of the World War I psychological ex-

amination program for the Army; founder of the Yale Laboratories of Primate Biology at Orange Park, Fla., and a pioneer in psychobiology; vice-president of AAAS Section H in 1919; 3 Feb.

## Education

■ Twelve technical writers from business and industry will be among the lecturers in the fourth annual Technical Writing Institute that is to be conducted at Rensselaer Polytechnic Institute from 11 to 15 June by members of the institute's faculty in language and literature. Jay R. Gould is the director. Nearly 200 representatives of 100 large companies have attended the previous annual sessions of the institute. The seminar of lectures and workshop testing is designed to bring help to those who supervise technical writing in business and industry and to those who are entering the technical writing field.

■ There are more dental students in the United States today than ever before in the history of the profession, according to the new 1955-56 *Dental Students' Register* published by the American Dental Association. This year's total of 12,730 students represents an increase of more than 50 per cent in the past 10 years.

■ A long-range study program, designed to determine the methods by which a medical center can best relate its programs of medical teaching, research, and patient care to the current and future needs of the community, has been launched at New York University-Bellevue Medical Center. The numerous facets of the study program will be correlated by a newly formed study group that will function with Allen O. Whipple, educator and surgeon, as consultant. Whipple will serve on a part-time basis. Two members of the faculty have been assigned to the study group on a full-time basis: William N. Hubbard, Jr., associate dean of the N.Y.U. College of Medicine, and Raymond S. Jackson, associate professor of medicine, N.Y.U. Post-Graduate Medical School.

Members of the faculties of the center will supply the basis for the study program by evaluating the present activities of the Medical Center and by submitting recommendations for improvements based on their findings, judgment, and experience. These will in turn be applied to pilot experiments at the Medical Center. The study program, which will also include a comparison of developments in medical education throughout the United States, has been made possible through a recent grant from the Commonwealth Fund.

■ The Tissue Culture Association is again sponsoring a course of instruction in the principles and techniques of cell and tissue culture. The course will be under the direction of Charles M. Pomerat of the University of Texas Medical Branch. It will be given at the University of Colorado School of Medicine from 16 July to 11 Aug. The tuition will be \$100.

The course is designed specifically for postgraduates (M.D. or Ph.D.) who plan to use cultured tissues in their research or teaching. Requests for application forms should be addressed to Dr. Mary S. Parshley, College of Physicians and Surgeons, 630 W. 168 St., New York 32, N.Y., and should be completed and returned to her not later than 1 May.

### Grants, Fellowships, and Awards

■ The Darbaker Prize Committee of the Botanical Society of America will accept nominations for an award that is to be announced at the annual meeting of the society in 1956. Under the terms of the bequest, the award is to be made for meritorious work in the study of the algae, particularly the microscopic algae. The committee will base its judgment primarily on the papers published by the candidate during the last two full calendar years previous to the closing date for nominations. Only papers published in the English language will be considered.

Nominations for the 1956 award, accompanied by a statement of the merits of the case and by reprints of the publications supporting the candidacy, must be received *before 1 May* by the chairman of the committee. The value of the prize for 1956 will depend on the income from the trust fund, but the amount is expected to be about \$150. For information, write to the secretary of the Botanical Society, Harold C. Bold, Vanderbilt University, Nashville, Tenn.

■ The Tobacco Industry Research Committee has announced a third allocation of \$500,000 to continue support of research by independent scientists into all phases of tobacco use. This amount brings the tobacco group's research fund allocations to \$1.5 million. In a little more than a year the committee's advisory board has recommended grants totaling more than \$838,000, of which \$25,800 has supported fellowships for medical school students.

The three main areas to which the board has directed its attention are the physical and chemical composition of tobacco and accompanying products; tissue changes in both human beings and in animals; smoking and other tobacco habits; and the emotional and physical makeup of smokers.

■ Through the generosity of George R. Cooley, the American Society of Plant Taxonomists has been able to announce that it will offer two cash awards yearly for a period of 5 years. One of these awards carries an honorarium of \$500, the other an honorarium of \$100.

The larger award is to be given for a published paper based on original research and concerned largely with the taxonomy of plants of the southeastern United States, including the states of Alabama, Arkansas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. Papers published in the calendar year prior to that in which the award is given will be considered by a special committee appointed by the society.

The committee is composed of Donovan S. Correll (chairman) of the Plant Industry Station, Beltsville, Md.; Harold W. Rickett of the New York Botanical Garden; and Edgar T. Wherry of the Botanical Laboratory, University of Pennsylvania. Papers should be sent to Correll for consideration.

The smaller award of \$100 is to be given for an oral paper on any phase of plant taxonomy delivered before the membership of the American Society of Plant Taxonomists at the program of its annual meeting. All papers given on the program will be considered by a committee consisting of Robert T. Clausen (chairman) of Cornell University; John M. Fogg of the Morris Arboretum, University of Pennsylvania; and H. L. Mason of the University of California, Berkeley.

Papers presented at the next annual meeting, which is to be held at the University of Connecticut, Storrs, 26-30 Aug. 1956, will be considered for the award.

■ The Public Health Service awarded 3036 research grants totaling \$36,522,408 between 1 July 1955 and 1 Jan. 1956 from funds appropriated for fiscal 1956. A summary of the research grants that have been approved for payment during the first half of the current year has been released. The grants support medical research on all major diseases and in the basic sciences related to medicine.

The 350 institutions that received the grants are located in 46 states, the District of Columbia, 2 territories, and 7 foreign countries. About 95 percent of the research funds for the current fiscal year have been committed. Of the 3036 grants, 634 were new. The remaining 2402 were continuation grants.

■ The National Science Foundation has announced that 164 grants, totaling about \$3,240,500, were awarded during the quarter that ended 31 Dec. 1955 for the support of basic research in the natural sciences, for conferences in sup-

port of science, for exchange of scientific information, and for summer institutes for refresher training of high-school and college undergraduate science teachers. This is the second group of awards to be made during fiscal year 1956.

### In the Laboratories

■ The High Voltage Engineering Corporation of Cambridge, Mass., has begun construction of an 88,000-square-foot radiation machine test plant on a 50-acre site in Burlington, Mass. The one-story building, to be ready for occupancy in September 1956, will contain enough radiation test vaults to allow operation of 16 accelerators simultaneously. The plan for each vault will be varied to provide for test of both Van de Graaff particle accelerators and microwave linear accelerators. The new facility will cost nearly \$2 million, a figure that includes specialized production and test equipment.

■ Formation of Resources Research, Inc., a firm of consultants that will specialize in solving air and stream pollution problems for industry and federal and state governmental agencies, has been announced by Louis C. McCabe, formerly of the U.S. Public Health Service. The main office of the new firm will be at 4435 Wisconsin Ave. NW, Washington 16, D.C.; there will be additional offices in New York at 55 W. 42 St., and in Casper, Wyo., care of P.O. Box 1861.

McCabe, who served as the first director of the Los Angeles Air Pollution Control District, will be joined in the new enterprise by Frederick S. Mallette, executive secretary of the Committee on Air Pollution Controls and research manager of the American Society of Mechanical Engineers, and William S. McCabe, consulting geologist of Casper, Wyo.

The company will conduct research and development work in geology, mining, industrial wastes, and water resources, and in the economics and supply of both conventional and atomic fuels.

■ The Lockheed Aircraft Corporation has announced establishment of a special projects engineering division within the engineering branch of its Georgia Division at Marietta. The new unit has been organized to help meet the demand for the development of prototype aircraft designs and special systems. Starting with some 50 engineers and designers drawn from other phases of Lockheed's engineering activities, the new division will add another 100 mechanical, structural, and systems specialists within the next 12 months.

## Reports and Letters

### High-Resolution Microradiography

A method has been developed for coupling the high penetrating power of x-rays with the high resolving power of the electron microscope (1). A high-resolution x-ray microscope has long been sought. Recent work by others has given a method for producing good x-ray micrographs with a useful magnification of about 1000 to 1500 diameters but with resolution far below that of the electron microscope. Our technique combines the best features of both x-rays and the electron microscope and for the first time gives x-ray micrographs at useful magnifications of 10,000 to 25,000 diameters, showing detail of the order of that hitherto seen only with the electron microscope. Biological specimens can now be examined in air or in the growing medium, so that the destructive and desiccating effects of the high vacuum and electron beam in the electron microscope are eliminated.

The basic technique consists of three steps: (i) making a relief image of the specimen in a grainless medium by means of the high penetrating power of x-rays; (ii) obtaining a thin replica of this relief, which is then shadow-cast and made suitable for examination with an electron microscope; and (iii) examining this replica under the high resolving power of the electron microscope.

The first step is the essential one and involves new techniques that make the subsequent steps practicable. Many substances are adequately sensitive to x-rays, particularly some of the finest-grained photographic emulsions, but all of them possess grain sizes that are readily apparent even under a light microscope and are far larger than the details we wish to examine. Even the finest grains of silver in available photographic emulsions are larger than the particles of carbon black, for instance, that we sought to resolve. Therefore, we initiated a search among known photo- and x-ray-sensitive substances for one that would show no structure in the electron microscope range. Bichromated gelatin is such a material, but it is not suitable for preparing replicas by presently known methods. Sub-

sequently, we found that faces of crystals of ammonium dichromate are adequately sensitive to x-rays and at the same time are free from structure in the interfering range.

When we attempted to grow large crystals of dichromate for this use, we found that the slight amount of solution adhering to the crystal as moisture deposits tiny crystals on the otherwise plane surface and that the plane surfaces crack on drying. The cracking and the infinitesimal crystals adhering tenaciously to the crystal faces destroyed the value of the crystals for our purpose. This necessitated development of a method whereby we might prevent both cracking and the formation of fine "after" crystals by diffusing away the thin residual layer of mother liquor.

We finally developed a successful technique that consisted of removing the crystal from the mother liquor and immediately agitating it in a viscous collodion solution. The collodion solution aids in washing off the residual mother liquor, and because it dries to a film on the crystal face, it provides a membrane through which moisture can diffuse slowly. When the collodion film has become completely dry, it can be stripped from the crystal, leaving a completely plane surface without either grain or roughness. Later, we found other materials—particularly certain types of plastic sheetings—that are free from structure in our working range and are also adequately sensitive to x-rays. Such a material is the commercial polyvinyl chloride-acetate film that undergoes change of solubility under x-ray bombardment.

The techniques for using either dichromate crystal faces or polyvinyl films are quite similar. The specimen is mounted tight against the sensitive surface so that there is no space between them and so that no motion of one with respect to the other is possible. This is necessary to cut down the width of the penumbra due to the 1-mm focal spot. Thicker specimens will require a finer focal spot or increased target-to-specimen distance. The combination is then mounted in the path of a carefully limited beam of soft x-rays for a sufficient period to form the

image. Exposure for the Thermax particles shown is approximately 23 hours at 9 to 10 kv and 20 ma, using vinyl film as a recorder.

The effect of the x-ray exposure is to change the solubility of the plane surface; the image is developed in relief by dissolving away the more soluble portions of the exposed surface. We have found a mixture of anhydrous alcohols satisfactory for developing the x-ray image on the dichromate crystal face. With polyvinyl films, we use 30-percent acetone in water. This enables us to secure satisfactory relief without softening the film.

A cast thin enough to permit the passage of the electron beam is then made of the relief surface, using silicon monoxide or other suitable material by familiar methods. The replica is mounted on the customary screen. Finally, the relief of the replica is emphasized by the familiar method of volatilizing a thin metal coating on it from an angle. We apply chro-

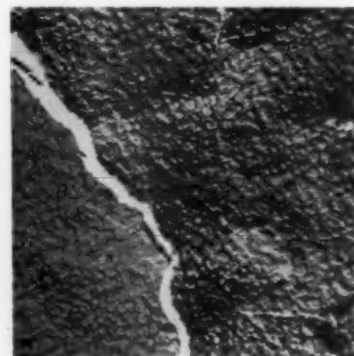


Fig. 1. X-ray micrograph showing thickly populated field of well-dispersed Thermax particles in polyvinyl alcohol; Particles show up as light "hollows." Two particles have been outlined in ink. The two solid black particles are actual Thermax particles (approximately  $\times 3333$ ).

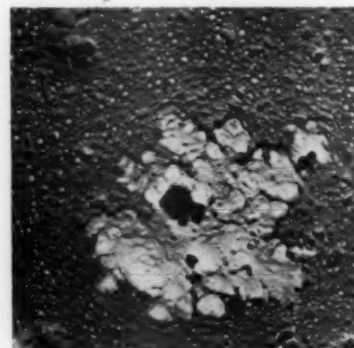


Fig. 2. X-ray micrograph showing "ciump" or aggregate of Thermax particles ( $\times 5000$ ).



mium. The shadow-cast replica is then ready for examination in the electron microscope.

By this means, we have been able to obtain excellent electron micrographs of carbon black particles showing variation in dispersion (Figs. 1 and 2). We have made pictures of blood cells at 5 kv, but much control work must still be done before proper interpretation can be made of the results. New techniques will enable us to picture bacteria and other living matter without exposure to the high vacuum of the electron microscope. We have pictured the overlapping of lead particles and structural differences that would not be resolved by the light microscope.

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#### Notes

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### Effects of Pentobarbital Sodium on Adaptive Behavior Patterns in the Rat

We have previously reported a relationship between the rat's behavior in our maze and cholinesterase (ChE) activity in the cerebral cortex (1). In each unit of our maze, the rat chooses between a lighted and a dark alley, only one of which is open. The lights and correct alleys are changed after each trial; thus following any one cue can bring only chance success. Nevertheless, the rat usually displays consistent choices ("hypotheses")—for example, consistently choosing lighted alleys or the left alleys. This hypothesis behavior represents a perceptual selectivity that is significant in the organism's normal adjustments (1).

The present experiment derived from the following considerations. (i) Illumination is evidently the dominant cue in our maze, since most animals start with a light-going preference. Persistence in this preference results in a light hypothesis. A spatial hypothesis requires ignoring the dominant visual cue. (ii) Animals with lower ChE activity display a preponderance of light hypotheses. Animals with higher ChE activity tend to abandon this preference and adopt spatial hypotheses (1). (iii) ChE activity is assumed to be an index of the rate of

acetylcholine (ACh) metabolism. (iv) Pentobarbital sodium reduces the rate of synthesis of ACh in the cortex (2).

These four points can be rephrased in the following hypothesis: Animals with low rates of cortical ACh metabolism are relatively incapable of ignoring the dominant visual cue. Therefore, pentobarbital, by depressing ACh metabolism, should increase light-going behavior.

Figure 1 shows the percentage of light-going choices per trial for three groups of 80-day-old male rats. Group I (control) choices showed the initial light-going tendency but soon fell to about 50 percent and remained there. Their hypotheses during days 1-4 were distributed fairly evenly among light, dark, left, and right (Table 1). Group I was of our C strain, a cross between maze-bright and maze-dull (D strain) rats (3). D rats (group IV,  $n = 24$ ) were more persistent in light-going behavior and rarely adopted other hypotheses. In comparison with C rats, D rats have lower cortical ChE activity (1).

Group II consisted of C rats run under pentobarbital on days 1-4. Ten milligrams per kilogram of body weight was injected intraperitoneally about 15 minutes prior to testing. This dosage did not reduce eating or increase maze running time. Figure 1 shows that their behavior was preponderately light-going as long as the barbiturate was used, most animals persistently displaying light hypotheses. When pentobarbital was not used (days 5 and 6) light-going choices fell off. Administering the drug on day 7 raised them again. The  $t$  test (Table 2) indicates highly significant differences between groups I and II. Peculiarities in the behavior of the drugged animals in-

cluded a rapid gait and lack of exploratory and "vicarious-trial-and-error" behavior. The whole picture was one of stereotypy.

To test whether the drug might have made the animals phototropic and unresponsive to the problem nature of the situation, ten animals of group II were later trained with the maze made solvable. On successive days the right, left, and dark alleys were correct. Most animals reduced their light-going behavior and followed these cues, even under the

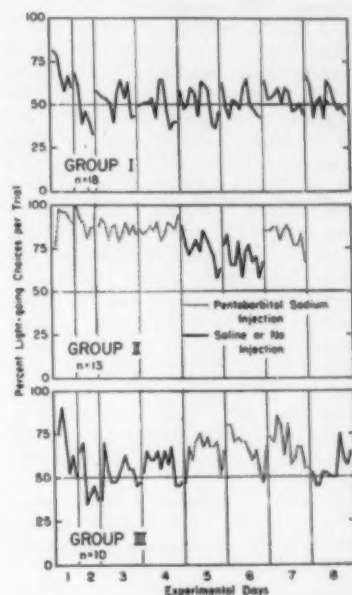


Fig. 1. Percentage of light-going choices per trial for three groups of rats.

Table 1. Frequency of various hypotheses per rat per day. An animal is credited with displaying a hypothesis if its choices during a day deviate from 50 percent, for any cue, by at least 2.5 standard deviations.

Group	Strain	Days 1-4				Days 5-6			
		Light	Dark	Left	Right	Light	Dark	Left	Right
I	C	.19	.11	.19	.13	.20	.06	.30	.08
II	C	.90	.00	.00	.05	.58	.00	.04	.04
III	C	.30	.10	.07	.10	.40	.10	.05	.10
IV	D	.36	.03	.14	.07				

Table 2.  $t$  Tests of differences between groups in the pentobarbital experiment (light-going scores).

Groups compared	Experimental days					
	1-2	3	4	5	6	7
I and II	7.62*	5.81*	6.15*	3.88*	3.07†	4.08*
II and III	7.61*	4.14*	3.35†	1.06	0.32	1.65
I and III	0.08	0.14	1.10	1.88	2.37‡	1.86

\*  $t$  significant at .001 level of confidence. †  $t$  significant at .01 level of confidence.

‡  $t$  significant at .05 level of confidence.



drug. As a further test, group III was run normally for 4 days and then under the barbiturate. Light-going behavior increased moderately under the drug but remained well below the level of group II. Group III actually displayed fewer light hypotheses while drugged than did group II when the drug was withdrawn. Clearly, pentobarbital does not create a simple phototropism.

The present data, together with our first report, seem consistent with the hypothesis that differences in adaptive behavior patterns are related to the rate of cortical ACh metabolism.

A possible additional interpretation is suggested by recent findings that afferent channels show habituation "... to stimuli which tend to be insignificant for the organism" (4). This habituation is due to inhibitory impulses from the brain stem reticular formation and is prevented by pentobarbital anesthesia or injury of the reticular formation. The inhibition can originate at levels above the brain stem (5). To initiate the inhibitory impulses may require a given rate of ACh metabolism. In our experiment, pentobarbital may have depressed the ACh metabolism enough to retard the initiation of these inhibitory impulses and thus forced the rat to "attend to" the dominant visual cue. We are here suggesting a biochemical mechanism for perceptual selectivity to complement the neurological one.

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#### Nuclei Counts on Rat Liver Homogenates

During the course of studies on the desoxyribose nucleic acid (DNA) per average nucleus in rat liver homogenates, it was observed that the number of nuclei per unit weight of liver was significantly greater than that reported by Einhorn *et al.* (1) and Price and Laird (2). These authors used the method of Price *et al.* (3) who had made the nuclei counts after

Table 1. Number of nuclei per gram of liver  $\times 10^6$ .

Rat No.	1(i)	1(ii)	2(i)	2(ii)
	10-second homogenate	15-minute homogenate	Tissue press 10-second homogenate	Tissue press 15-minute homogenate
1	4.13	2.00	3.98	2.19
2	4.10	2.06	4.16	2.13
3	3.87	2.10	3.85	2.06
4	3.97	2.17	3.80	2.12
5	3.82	2.16	3.82	2.08
6	3.95	2.05	3.97	2.20
Mean $\pm$ S.E.*	3.97 $\pm$ 0.050	2.09 $\pm$ 0.027	3.93 $\pm$ 0.056	2.13 $\pm$ 0.023
<i>P</i> <sup>†</sup>				
	1(i)-1(ii)	1(ii)-2(i)	2(i)-2(ii)	1(ii)-2(ii)
	<i>P</i> > .001	<i>P</i> > .7	<i>P</i> > .001	<i>P</i> > .3

\* Standard error (S.E.) computed by standard deviation (S.D.) =  $\sqrt{\frac{\sum x^2 - (Mx\sum x)}{n-1}}$ ; S.E. =  $\frac{S.D.}{\sqrt{n}}$

† *P* = probability from Fischer's table "t."

a 15-minute homogenization in sucrose, whereas we had homogenized the tissue for a period of less than 30 seconds in 0.85-percent saline. The present study (4) was designed not only to determine the effect of homogenization time on nuclei counts but also to evaluate the effect of passing the tissue through a tissue press prior to homogenization.

Female rats of the Sprague-Dawley strain, given free access to Purina laboratory chow and water, were used. The animals were sacrificed by a blow on the head, and the livers were excised, weighed, and immediately cooled to 0°C. The following variations in homogenization technique were used:

1) A 10-percent homogenate in 0.85-percent saline was prepared employing homogenization times of (i) 10 seconds and (ii) 15 minutes.

2) The liver was first passed through a tissue press, then a 10-percent homogenate was prepared in 0.85-percent saline employing homogenization times of (i) 10 seconds and (ii) 15 minutes.

A modified Potter-Elvehjem tissue grinder with a motor-driven, loosely fitting, longitudinally grooved plastic pestle was used. After homogenization, a 2-ml aliquot was mixed thoroughly with an equal volume of crystal violet solution (80 mg of crystal violet in 100 ml of 6-percent acetic acid). A drop of the mixture was placed under the cover slip of a Petroff-Hausser bacteria-counting chamber, and the nuclei were enumerated. Five counts were made on each preparation, and the average of these counts was recorded. The counts on animals 1, 2, and 3 were made by one person and counts on animals 4, 5, and 6 were made by another. This was done in order to eliminate human error insofar as possible.

Table 1 shows that mincing the liver in a tissue press has no effect on the number of nuclei obtained. However, when the tissue was homogenized for 15 minutes, the nuclei were reduced to almost half the number obtained in the 10-second homogenization. Regardless of the method of preparation, there was no significant variation in the amount of DNA per unit weight of tissue when determined by the Disch diphenylamine method (5): (i) 39.7 mg of DNAP per 100 g of liver with 10-second homogenization and (ii) 38.7 mg of DNAP per 100 g of liver with 15-minute homogenization. It is obvious that the DNA per nucleus in the groups that had been homogenized for 15 minutes would be approximately double that of groups that had been homogenized for 10 seconds.

These data indicated that more nuclei were destroyed during the longer period of homogenization. This was confirmed in the following manner: aliquots of the 10-second and 15-minute homogenates were taken and centrifuged at 1000 rev/min for 20 minutes, and then the DNA content of the supernatant was determined. Microscopic examination of the supernatant established that it was free of nuclei in each case. Analysis of the cell-free supernatant of the 15-minute homogenate showed an increase in DNA corresponding to the decrease in nuclei count. To evaluate the accuracy of the nuclei-counting technique, the DNA values per nucleus were determined on two samples of the same liver; one sample was used for the isolation of nuclei by the citric acid method, and the other sample was used for the determination of nuclei by the 10-second homogenization procedure described here. The values obtained for both samples agreed within 2 percent. Moreover, nuclei counts made with a

bacteria-counting chamber showed no significant difference from those made with a hemacytometer.

The data presented indicate that prolonged homogenization will destroy liver cell nuclei, and that, in order to obtain accurate DNA values per average nucleus from homogenate suspensions, the homogenization time must be reduced to such an extent that the DNA in the nuclei-free supernatant fraction is negligible.

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### Grouping in Spatial Distributions

A number of procedures have been developed in recent years for measuring departures from randomness in the spatial distribution of points, but few analytic attempts have been made to separate the factors responsible for these deviations. Lack of randomness in a distribution of points over a given space may result (i) from the influence, on the location of the points, of regional differences in the nature of the space, and (ii) from the influence of the points on the position of one another. Evaluation of the importance of these two sources of nonrandomness in a given population has been complicated by the fact that current measures of nonrandomness are simultaneously sensitive to both of them. It is the purpose of this paper (1) to suggest a method whereby grouping in spatial distributions can be exhaustively described and by means of which, under certain circumstances, the aforementioned causes of nonrandomness can be distinguished.

It has been shown by Clark and Evans (2) that in a random distribution in two-dimensional space the proportion of points for which the relation of nearest

$$dP_n = \frac{k}{(n-1)!} \left[ \frac{\rho \pi^{k/2}}{\Gamma(k/2+1)} \right]^n r^{kn-1} e^{-2r^k \rho} \left[ \frac{\pi^{k/2}}{\Gamma(k/2+1)} - \frac{\pi^{k/2}}{\Gamma(k/2+1)} \int_0^1 (1-x^2)^{k/2-1} dx \right] dr$$

Formula 1

$$kP_n = \int_0^\infty \frac{k}{(n-1)!} \left[ \frac{\rho \pi^{k/2}}{\Gamma(k/2+1)} \right]^n r^{kn-1} e^{-2r^k \rho} \left[ \frac{\pi^{k/2}}{\Gamma(k/2+1)} - \frac{\pi^{k/2}}{\Gamma(k/2+1)} \int_0^1 (1-x^2)^{k/2-1} dx \right] dr$$

Formula 2

neighbor is reflexive—that is, points which are the nearest neighbor of their nearest neighbor—is .6215. This expected proportion of reflexive relationships is independent of whether the density of the distribution is constant over the space occupied by it, but it is increased by any tendency for the formation of groups of two. It often happens, however, that distributional factors result in the formation of groups larger than two without appreciably affecting the number of pairs. The following generalization of the concept of reflexivity is applicable to groups of any size.

In a random distribution in  $k$ -dimensional space, consider the point  $X_0$  and its 1st, 2nd, . . . ,  $n$ th nearest neighbors, designated  $X_1, X_2, \dots, X_n$ . The relation of  $n$ th nearest neighbor is reflexive for  $X_0$  if  $X_n$  is closer to  $X_0$  than to any other points except  $X_1, X_2, \dots, X_{n-1}$ . Morisita (3) has obtained the probability distribution of the distance,  $r$ , to the  $n$ th nearest neighbor for a random distribution of density  $\rho$  in two-dimensional space. In  $k$  dimensions it is formula 1. Consequently, employing the reasoning of Clark and Evans (2), the proportion of points for which the relation of  $n$ th nearest neighbor is reflexive in a  $k$ -dimensional random distribution is formula 2, which upon integration becomes formula 3.

For 1, 2, and 3 dimensions we have, respectively,

$$\begin{aligned} {}_1P_n &= (2/3)^n \\ {}_2P_n &= \left( \frac{6\pi}{8\pi + 3^{3/2}} \right)^n \\ {}_3P_n &= (16/27)^n \end{aligned}$$

Values of  ${}_2P_n$  for  $n=1-21$  are given in Table 1.

For the purpose of this discussion, it is convenient to define a group as a collection of points in which every individual is closer to some member of the collection than to any individual outside of it. The concept of a group, as so defined, is a hierarchical one, large groups containing smaller ones within them. Groups occur in random, as well as in nonrandom, distributions. Nonrandom distributions differ from random ones in the extent to which the groups are isolated, increased isolation of groups being characteristic of aggregated distributions and decreased isolation, of distributions that tend toward uniformity. A group may be said to be completely isolated if each of its members is closer to every

$$kP_n = \left[ \frac{\frac{1}{2}\pi^{k/2}}{\Gamma(k/2+1)} - \frac{\pi^{k/2}}{\Gamma(k/2+1)} \int_0^1 (1-x^2)^{k/2-1} dx \right]^n$$

Formula 3

other member than to any individual outside of the group, from which it follows that every group of two individuals is completely isolated. The delimitation and counting of groups is not likely to facilitate distributional analysis unless the groups are highly isolated.

Although the group is ordinarily not a useful unit in distributional studies, a measure of the tendency for isolation of groups of specified size in a population is of value in describing spatial pattern. The tendency for isolation of groups of size  $n$  in a population may be called *grouping of order  $n$* , positive, neutral, and negative grouping implying tendencies for isolation respectively greater than, equal to, and less than that expected in a random distribution. It is apparent that the observed proportion of individuals for which the relation of

Table 1. Proportions of individuals for which the relation of  $n$ th nearest neighbor is reflexive for populations in two-dimensional space.

n	Size of sample		
	Random distribution	Lespedeza	Prairie-dog burrows
1	.6215	.609	.642
2	.3863	.435	.246
3	.2401	.152	.134
4	.1492	.168	.084
5	.0927	.098	.028
6	.0576	.060	.011
7	.0358	.065	.006
8	.0223	.027	.006
9	.0138	.038	.000
10	.0086	.027	.000
11	.0053	.038	.000
12	.0033	.087	.000
13	.0021	.022	.000
14	.0013	.043	.000
15	.0008	.049	.000
16	.0005	.033	.000
17	.0003	.060	.000
18	.0002	.027	.000
19	.0001	.049	.000
20	.0001	.147	.000
21	.0000	.098	.000

$n$ th nearest neighbor is reflexive in a given population corresponds with grouping of order  $n+1$ , the proportion being less than, equal to, or greater than that expected in a random distribution, depending on whether grouping of order  $n+1$  is negative, neutral, or positive. The significance of differences between these proportions can be tested by chi-square if the points for which nearest neighbor relationships are ascertained represent a proportionately small random sample of the entire population under investigation. It should be noted that the proportion of reflexive relationships is increased in the vicinity of distribution borders and that the relation of  $n$ th nearest neighbor is reflexive for every individual in a completely isolated group of  $n+1$  points.

Negative grouping is nearly always attributable to the influence of the points on the position of one another, whereas positive grouping can result both from this cause and from discontinuities in the nature of the space. Discontinuities in the space usually result in positive grouping of higher order than that induced by interaction between points. Information about such discontinuities usually enables one to attribute positive grouping below a certain order to the influence of the points on the position of one another.

As an illustration of the foregoing ideas, the proportion of individuals for which the relation of  $n$ th nearest neighbor is reflexive, for  $n=1-21$ , was ascertained (4) for a natural distribution of the grassland plant *Lespedeza capitata* Michx. occurring on an abandoned field near Ann Arbor, Michigan (5), and for the distribution of burrow openings over part of a prairie-dog town in the Black Hills of South Dakota (6). As is shown in Table 1, positive grouping is predominant in the *Lespedeza* distribution, whereas negative grouping characterizes the distribution of prairie-dog burrows. Positive grouping in *Lespedeza* probably results from its reproductive habits. The negative grouping of the burrows is a consequence of the social behavior of prairie dogs.

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1 September 1955

### Effect on *Meloidogyne hapla* of Excised Tomato Roots Treated with Alpha-Methoxyphenylacetic Acid

A method that permits root portions to be tested quantitatively for their effect on the soil stage of plant-parasitic nematodes was recently described (1). It was shown that the excised distal portion of the tomato root consists of three regions with respect to its effect on larvae of *Meloidogyne hapla*, Chitwood (Nematoda): (i) apical 2 mm (calyptra and meristematic region), repellent; (ii) following 6 mm (region of elongation), attractive; (iii) remainder, up to 16 mm behind the root apex, neutral or slightly repellent. Since the nematodes proved to be extremely sensitive, one of the conclusions reached from this work was that plant-parasitic nematodes could be used as test subjects for the detection of excretion from roots of substances given off in very small amounts. This might be of value in connection with experimental work on compounds that (i) can be sprayed on the aboveground parts of susceptible crop plants, whence they are transported downward and excreted through the roots and (ii) are at the same time nematode-repellent. So far no such compound that is not at the same time harmful to the plants has been found. However, in the search for such a compound, the method I described (1)

might be useful in determining whether a chemical being tested is or is not nematode-repellent.

It has been shown that alpha-methoxyphenylacetic acid (MOPA) causes growth responses (2) and that it is transported from the upper parts of several kinds of plants downward and that the compound or a derivative of it is excreted through the roots (3). The fact that MOPA moves downward in tomato stems and out of the roots has been demonstrated more recently. This was shown by first growing MOPA-treated tomato plants (4) and comparable untreated ones separately in beakers containing aerated water and then, 4 days later, replacing the tomatoes with young bean plants. After 7 days, the trifoliate leaves of the bean plants in water that had supported growth of MOPA-treated tomatoes were typically malformed and smaller (52 percent) than those of beans in water that had supported growth of untreated tomatoes.

A further clue of downward transport is provided by the reaction of the nematodes. The results are shown in Fig. 1. A summary of the method employed follows (the details have been reported, 1). Egg masses of *M. hapla* are placed in the center of a sand-filled dish. One of the halves of the dish contains a root piece, the other does not. The results are expressed as the percentage of hatched lar-

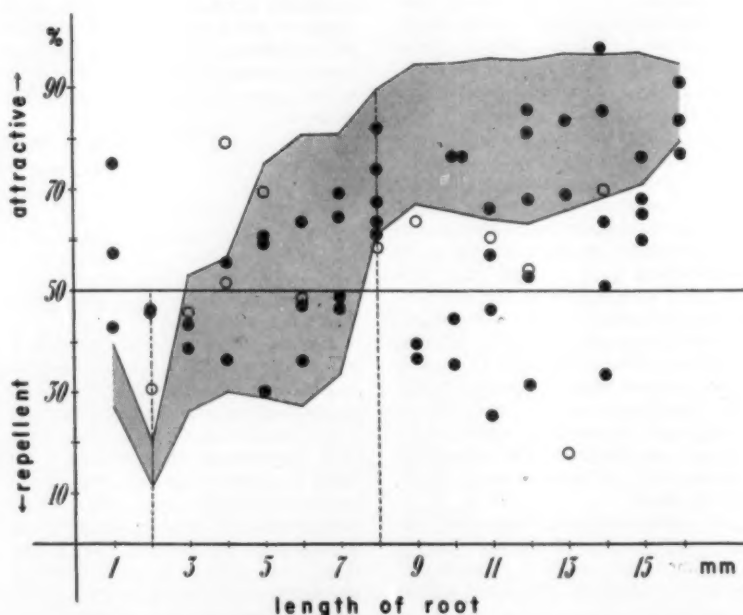


Fig. 1. Effect of excised root ends from tomatoes treated with alpha-methoxyphenylacetic acid (MOPA) on larvae of *Meloidogyne hapla*. Samples were taken 1 to 3 days (filled circles) or 5 to 7 days (open circles) after treatment. Stippled field: range of variability of effect of excised roots from untreated plants. Abscissa: length of root end. Ordinate: percentage of nematodes found in the half of the dish occupied by the root end.

vae found in the half of the dish that contains the root piece. Each filled or open circle represents one sample (such samples were used only when 20 or more larvae were hatched from the egg masses). Thus, a high percentage in Fig. 1 signifies attractiveness of the tested root piece and a low percentage, repellency. All filled and open circles show the effect of the excised roots taken from MOPA-treated tomato plants. The stippled field is superimposed to show the whole range of variability of the effect of excised roots taken from untreated tomato plants on the nematodes as previously determined (1).

Although there is an obvious correlation in untreated plants between the length of the excised root end and its degree of attractiveness—the latter reaching a maximum at a root length of 8 mm and staying at that high level to a length of at least 16 mm—this correlation breaks down in the MOPA-treated plants. Although a number of the tested root portions still proved to be attractive, especially if they measured more than 8 mm, nonattractive and repellent samples also occurred at the same lengths. This seems to indicate that the MOPA treatment upsets the clear-cut effect of the attractive agent present in excised roots of untreated tomatoes but that it does not destroy the agent.

Whether a given root piece is attractive to the nematodes seems to depend on an interplay between this attractive agent and a repellent agent, represented by MOPA or produced in the presence of MOPA. If the attractive agent is of high concentration in a given excised root, it will prevail over the MOPA or any repellent influenced by MOPA. This holds particularly for root ends longer than 8 mm. At shorter lengths, the variation of the effect is also high in untreated plants. This makes it impossible to discern a possible MOPA effect in this region. It should also be noted that the repellent effect of the apical 2 mm of the roots that was so obvious in untreated plants (1) seems to have disappeared in the treated plants.

If segmentation of the distal root portion is disregarded, the effect of the treated and untreated samples is significantly different. Student's *t* test was used in testing the regression coefficient of the treated and the untreated material. With 55° of freedom, a *t*-value of 5.2, which is highly significant, was obtained.

As has already been mentioned, this result does not establish beyond doubt the storage of MOPA in, or its excretion from, roots, but it shows at least that the treatment of the plant with MOPA induces in the root the appearance of some agent that is still present in the distal portion of the root after it has been ex-

cised and left in wet sand for 24 hours, and that this agent has a repellent effect on larvae of *M. hapla*. The attractive agent that occurs in the region of growth of the untreated tomato root, however, is not destroyed by it. The data presented are not interpreted as indicating any practical use of MOPA for control of nematodes.

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3. W. H. Preston, Jr., J. W. Mitchell, W. Reeve, *ibid.* 119, 437 (1954); oral communications.
4. The treatment of tomato plants with MOPA was carried out by J. W. Mitchell and W. H. Preston, Jr., of the Horticultural Crops Research Branch, U.S. Department of Agriculture. MOPA was mixed with 1 part of Tween 20 and 4 parts of lanolin and applied as a band around the node of the second set of true leaves just after they had been formed. Mitchell was also the first to suggest to me the use of MOPA for the treatment, and I am indebted to him for much valuable advice.
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2 September 1955

### Conversion of Lactate into Glycogen in Skeletal Muscle of Hepatectomized Rats

The synthesis of glycogen from lactic acid in skeletal muscle has been investigated from time to time. In most books on biochemistry, the discussion of this metabolic process is incomplete or else it is omitted, probably because of the contradictory results that have been reported by different groups of investigators.

According to Meyerhof, Lohmann, and Meier (1), the hind legs of frogs,

when perfused with D-lactic acid solutions at pH 7.4, increased their oxygen consumption and converted some of the lactic acid into glycogen. When Eggleston and Evans (2) repeated these experiments, they observed no synthesis of muscle glycogen. By injecting lactic acid intraarterially into the hind legs of dogs, Elias and Schubert (3) were unable to find any formation of muscle glycogen. Janßen and Jost (4) reported that perfusion of hind legs of dogs with DL-lactate caused no increase in glycogen content. Takane (5) showed that the isolated diaphragm of rat was unable to synthesize glycogen from lactic acid. Using heart muscle, Cavert and Johnson (6) found that perfusion with sodium lactate-1-C<sup>13</sup> or lactate-2,3-C<sup>13</sup> did not yield glycogen labeled with C<sup>13</sup>. Despite the failure of many investigators to demonstrate the conversion of lactic acid into glycogen in mammalian muscle, Long and Horsfall (7) claimed that infusion of decapitated eviscerated cats with 2 to 10 percent of D-lactic acid solution at the rate of 12 to 13 ml/hr caused either insignificant or no increase in muscle glycogen.

In all of the literature cited, except one article, the results were obtained from isolated muscle and might not be the same as those from intact muscle. However, in the experiments of Long and Horsfall with intact muscle of decapitated eviscerated cats, the synthesis of muscle glycogen from infused lactic acid alone was not consistently and definitely indicated. Since the data are inconclusive, experiments to show the formation of glycogen from lactic acid in skeletal muscle have been undertaken (8).

Six Wistar rats were hepatectomized according to the method of Cheng (9). Each hepatectomized rat was injected with 80 µc (2.96 × 10<sup>6</sup> disintegration/sec) of sodium DL-lactate-2-C<sup>14</sup> (specific activity 1 mc/mmole per kilogram of

Table 1. Conversion of injected sodium lactate-2-C<sup>14</sup> into carbon dioxide-C<sup>14</sup> and muscle glycogen-C<sup>14</sup> in ½ hour. Radioactivity is indicated in disintegrations (d)/sec.

Rat No.*	Wt. (g)	Total activity of lactate-2-C <sup>14</sup> injected (10 <sup>6</sup> d/sec)	Specific activity of expired CO <sub>2</sub> (10 <sup>6</sup> d/sec mg)	Total activity of expired CO <sub>2</sub> (10 <sup>6</sup> d/sec)	Lactate-2-C <sup>14</sup> catabolized into CO <sub>2</sub> (%)	Specific activity of CO <sub>2</sub> obtained from glycogen (d/sec mg)	Total activity of glycogen isolated (10 <sup>6</sup> d/sec)	Lactate-2-C <sup>14</sup> converted (%)
90	330	9.77	6.23	5.95	0.61	7.48	2.18	0.22
91	402	11.90	7.61	10.57	0.89	6.80	4.47	0.38
93	434	12.83	6.34	9.77	0.76	5.78	2.55	0.20
92	290	8.58	8.25	11.78	1.37	8.60	4.73	0.55
93	279	8.26	12.78	16.60	2.01	8.33	3.31	0.40
94	256	7.58	4.86	3.52	0.47	9.92	4.35	0.57
96	229	6.78	3.30	4.94	0.73	12.34	3.71	0.55

\* The first three rats were male and the last four were female; rat 96 was normal.



body weight. Since each rat used in this investigation weighed 230 to 400 g, the amount of radioactive lactate required ranged from 2 to 3.6 mg. One hundred microcuries or 11.2 mg of sodium DL-lactate-2-C<sup>14</sup> were dissolved in 6 ml of physiological saline. The volume of solution containing the required amount of the radioactive lactate was measured in a 2-ml hypodermic needle and injected into the femoral vein. The carbon dioxide expired by the rat was collected and converted into barium carbonate for activity measurement in the usual manner. Because an insufficient amount of DL-lactate-2-C<sup>14</sup> was available, only one control was run—a normal rat was injected with the same dosage of radioactive lactate.

The rats were sacrificed 30 minutes after the injection. All the skeletal muscle was immediately removed and used for the isolation of glycogen by a procedure modified from the methods of Pflüger (10), Starkenstein and Henze (11), and McDowell (12). The glycogen was oxidized with chromic acid and the activity of carbon dioxide collected was measured as before.

As shown in Table 1, the formation of glycogen-C<sup>14</sup> appears to indicate the ability of skeletal muscle of rats, and presumably of other mammals also, to convert lactic acid directly into glycogen. It is also possible that lactic acid-C<sup>14</sup> was first oxidized into carbon dioxide-C<sup>14</sup> and that the latter then took part in synthesizing the glycogen-C<sup>14</sup> of skeletal muscle. However, since the specific radioactivity of carbon dioxide obtained from oxidizing the glycogen of the skeletal muscle did not run parallel with that of the expired carbon dioxide, the conversion of lactic acid into glycogen via carbon dioxide intermediate, if any, is evidently not the only process of glycogen formation in the skeletal muscle. On the other hand, it is unlikely that within the short duration of these experiments the glycogen-C<sup>14</sup> present in the skeletal muscle was derived from glucose synthesized in some other organs from the injected lactate. When the activities of glycogen isolated from hepatectomized and normal rats are compared, it appears that rats with or without livers synthesize glycogen from lactic acid at about the same rate.

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8 November 1955

## Electrophysiological Correlates of a Conditioned Response in Cats

The search for neurophysiological correlates for psychological phenomena such as learning and emotion has a long history that cannot profitably be treated here. This report presents a brief account of some electric changes that are observable in the brain when animals are conditioned and extinguished to an auditory stimulus.

The animals under study lived in a box measuring 0.5 by 1.0 by 0.5 m that contained a loud-speaker through which clicks (at constant intensity) were delivered at a rate of 1 click/3 sec along with noise generated by a thermionic noise generator. The noise intensity was adjusted at the outset so that it was sufficient to mask most ambient sounds. Recording from brain structures was achieved through electrodes of the Delgado type that were implanted stereotactically at sterile operation some weeks or months prior to the testing; as many as 14 separate brain locations were thus made available for study in each animal. To date, ten cats with implantations in or on auditory and visual cortex, cochlear nucleus, hippocampus, caudate nucleus, septal area, and amygdala have been examined in the conditioning process. The electrodes were directly connected through a plug to the amplifiers of a Grass EEG machine and thereafter, alternately or simultaneously, to inkwriters and a cathode-ray oscilloscope. The cats also wore a harness bearing two metal brushes, each making contact with one side of the thorax; the output of a Grass stimulator could be delivered to these brushes, and thus shocks could be applied, at will, across the chest of the animal.

The plan and results of the experiments are as follows. The animals were placed in the box for periods of many days or weeks, clicks being delivered continuously day and night throughout. From time to time their electrodes were connected to the recording devices, and the activity evoked by the clicks was visualized. The report (1) that under such conditions the response at the cochlear nucleus becomes, with time, much reduced in size ("habituation," "adaptation") was readily confirmed; in addition, we found that responses evoked in various other brain loci diminished in a similar manner. Responses so attenuated in the cochlear nucleus can be seen in the left column of Fig. 1.

After an animal had been in the box for hours or days, the tracings from its brain showed small, absent, or irregular evoked potentials caused by the clicks, and consistent behavior toward the stimuli was absent. At this point single strong shocks were given across the chest contiguously with randomly selected clicks. After these shocks had been discontinued—perhaps some 10 or 20 having been given—the behavior in response to the click stimuli was noticeably different. The animals crouched, appeared alert, and most of them twitched, snarled, or otherwise responded to many individual clicks. When exhibiting this behavior, the animals were considered to have been "conditioned" to the auditory stimulus; records from the cochlear nucleus of

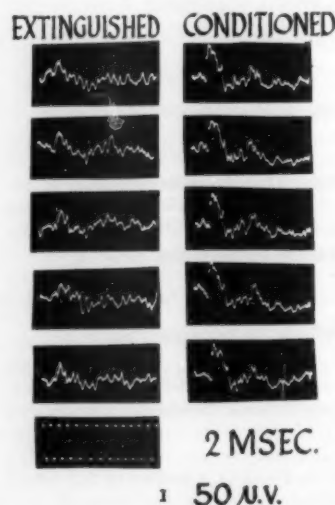


Fig. 1. Cochlear nucleus responses to successive identical click stimuli before ("extinguished") and after ("conditioned") application of three shocks to a cat. The increase in response magnitude after shocks as noted here has been observed eight times in this animal, two of them previous to the instance given here.



buffer homogenate by the differential centrifugation method of Schneider and Hogeboom (2). The microsomes were washed once each with isotonic KCl and distilled water. The supernatant was dialyzed for 24 hours against distilled water and then lyophilized. Mitochondria were isolated from an 0.88M sucrose homogenate (2). Taurocholic acid was routinely determined with the use of the furfural-H<sub>2</sub>SO<sub>4</sub> reaction of Pettenkofer (3) after free cholic acid had been removed by extraction with acetone and ethyl ether in the proportion of 1 to 2 and ethyl ether. The identity of the product as taurocholic acid was confirmed by paper chromatography.

Incubation of 50 mg of washed, lyophilized guinea pig liver microsomes with 4  $\mu$ moles of coA, 10  $\mu$ moles of cholic acid, 44  $\mu$ moles of adenosine triphosphate (ATP), and 30  $\mu$ moles of MgCl<sub>2</sub> in 1.0 ml of 0.1M K<sub>2</sub>HPO<sub>4</sub> buffer at pH 7.6 for 60 min resulted in the formation of 2.2  $\mu$ moles of a cholic acid derivative. When the compound was chromatographed on Whatman No. 1 filter paper, an ultraviolet absorbing band having the  $\lambda_{\text{max}}$  of adenine was noted at an  $R_f$  of 0.62 (60-percent propanol in H<sub>2</sub>O) or at an  $R_f$  of 0.81 (50-percent ethanol in H<sub>2</sub>O). Spraying a portion of the paper with the SbCl<sub>5</sub>-acetic acid spray, that has been described previously (4) revealed a single rose-colored band that is characteristic of cholic acid. This band coincided exactly in position and shape in both solvent systems with the position and shape of the 260-m $\mu$  absorbing band; the compound was further identified as choly coA by means of color reactions listed in Table 1. Finally, hydrolysis of the com-

Table 1. Identification of choly coA.

Test	Result
Cholic acid (SbCl <sub>5</sub> HAc) (4)	+
Adenine ( $\lambda_{\text{max}}$ 260 m $\mu$ )	+
RSH (nitroprusside) (8)	-
$\begin{array}{c} \text{O} \\ \parallel \\ \text{RS}-\text{C}-\text{R}' \text{ (NaOH-nitroprusside) (8)} \end{array}$	+
$\begin{array}{c} \text{O} \\ \parallel \\ \text{RS}-\text{C}-\text{R}' \text{ (hydroxylamine-FeCl}_3 \text{) (9)} \end{array}$	+
Ester phosphate (ammonium molybdate-HClO <sub>4</sub> ) (10)	+

Table 2. Role of choly coA in taurocholic acid synthesis. The figures in parentheses in column 1 are (i) amount, in millimoles, of choly coA and cholic acid and (ii) amount, in micromoles, of taurine added to the supernatant. The final volume was 0.6 ml in 0.03M K<sub>2</sub>HPO<sub>4</sub> buffer at pH 7.6.

Compound(s) added to 20 mg of dialyzed liver supernatant	Taurocholic acid synthesized (m $\mu$ mole)
Choly coA (118)	0.0
Choly coA (118) pretreated with base* + taurine (24)	0.0
Cholic acid (166) + taurine (24)	0.0
Choly coA (118) + taurine (24)	85.3

\* Choly coA in 0.1 ml water, hydrolyzed by the addition of 0.1 ml 4N NaOH and incubation for 2 min at 37°C. The mixture was neutralized with H<sub>2</sub>SO<sub>4</sub> before addition of the liver supernatant.

pound resulted in the appearance of two bands on paper chromatograms, one having the  $R_f$  value and color reaction of cholic acid, the other having the  $R_f$  value and color reaction of coA.

If chromatographically pure choly coA is incubated together with taurine in the presence of dialyzed guinea pig liver supernatant, taurocholic acid is produced (Table 2); this demonstrates that choly coA is an intermediate in the synthesis of the conjugated bile salt.

Taurocholic acid can also be readily synthesized by combining the reactions given in Eqs. 1 and 2. Microsomes, dialyzed supernatant, cholic acid, coA, ATP, and taurine are all required for taurocholic acid production in this overall reaction. Either microsomal or supernatant fraction alone is inactive.

The enzyme responsible for cholic acid activation would appear to be distinct from those that catalyze the formation of the coA derivatives of fatty acids (5, 6), benzoic acid (6) and *p*-aminobenzoic acid (7) in that the intracellular distribution of the other activating enzymes and, in one case, the tissue localization as well, are quite different from that of the choly coA-forming enzyme. The bile acid activating enzyme is found only in the microsomes of liver. Liver mitochondria are inactive and no kidney fraction will carry out the reaction. The enzyme

that activates short-chain fatty acids, benzoic acid, and *p*-aminobenzoic acid, on the other hand, is known to be localized in the mitochondria of both liver and kidney (6, 7). Likewise, the long-chain fatty acid-activating enzyme of liver supernatant (5), which in our studies readily synthesized palmityl coA, is incapable of so activating cholic acid.

The activating system was also found to be capable of catalyzing the formation of other bile acid-coA derivatives. Desoxycholy coA and C<sup>14</sup>-labeled lithocholy coA have been prepared in micro-mole quantities. Their roles in the scheme of bile acid metabolism, with regard to both conjugation and interconversions, are now under study.

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#### References and Notes

1. Since completion of this paper, Elliott [*Biochim. et Biophys. Acta* 17, 440 (1955)] has reported that optimal formation of choly hydroxamic acid by liver microsomes required the presence of ATP, coA, and cysteine. This finding is consistent with the observation, reported here, that choly coA is produced by such a system.
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#### Correction

The names of the compounds in the last three lines of Table 1 in "Inhibition of the effect of some carcinogens by their partially hydrogenated derivatives" by Kotin, Falk, Lijinsky, and Zechmeister [*Science* 123, 102 (20 Jan. 1956)] should read dihydrodibenzanthracene, decahydrodibenzanthracene, and perhydrodibenzanthracene.

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3 February 1956

*The beauty of electricity, or any other force, is not that the power is mysterious and unexpected . . . but that it is under law and that the taught intellect can even now govern it largely.—M. FARADAY.*

## Book Reviews

**Administrative Medicine.** Transactions of the third conference, 6-8 Oct., 1954, Princeton, N.J. George S. Stevenson, Ed. Josiah Macy, Jr., Foundation, New York, 1955. 172 pp. \$3.

The third conference on administrative medicine held by the Macy Foundation in October 1954 was part of a program intended to deal more effectively with hidden obstructions to communication. The conferences are designed to achieve earlier evaluation of new data and to further understanding among members of different scientific disciplines as soon as new insights and skills develop. The program also endeavors to cope with unrecognized blind spots, to overcome prejudices, and to lessen the uncritical acceptance of the dicta of authorities.

Following a presentation of the foundation's objectives by Frank Fremont-Smith, the special characteristics of problems in medical administration were outlined by Edward S. Rogers. Anthony J. J. Rourke considered the qualifications and educational requirements of medical administrators and discussed motivation and selection factors that draw individuals into this field rather than into business and industrial management.

To illustrate the relationship of a hospital to the community it serves, Ray E. Trussell used as a prototype the Hunterdon County Medical Center, a private nonprofit corporation in New Jersey. He described in detail the establishment of the hospital, the basis of practice in the center by general practitioners and specialists, and the training of students from medical schools in the area. An interesting administrative device at the hospital is the joint advisory committee composed of three staff members and three trustees, which functions like the pyramidal tract, by transmitting emergency orders directly to the site of action, bypassing the usual administrative routine.

W. W. Tudor presented the personnel and merchandizing policies of Sears, Roebuck and Company and discussed the advantages of decentralized management. He showed how principles of business administration could be applied in the management of hospitals. In looking

at administrative functions and techniques, Herbert Emmerich called attention to the consent-getting or external relations role of administrators who serve the public and pointed out that it requires different skills from those used in internal management. Bradley Buell emphasized the need for precise definition of community problems that require collective action, development of procedures for the integration of major specialized services, and training of professional personnel in those procedures.

During and after each of the presentations by the six guests, 13 conference members contributed uninhibited discussions that were allowed by George S. Stevenson, editor of the transactions, to retain their original spontaneity.

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**Soil Warming by Electricity.** R. H. Coombes. Philosophical Library, New York, 1955. 116 pp. + plates. \$4.75.

I must confess that I embarked upon my task of reviewing this little book (116 pages) with open curiosity. In my mind's eye I conjured all kinds of profundity in a book published by the Philosophical Library and bearing the intriguing title *Soil Warming by Electricity*. I was doomed to disappointment. Never have I seen a book more aptly characterized by its title. The little volume is painstakingly detailed in describing exactly how to install electric heating wires in the earth and how economically to outwit the climate by growing anything from beans to pineapples under heated frames. No American experiment station bulletin could be more practical than this handy British work, and gardeners and commercial horticulturalists should find it useful.

For those with a speculative bent, the book does have a certain charm. Only a Briton could trace the evolution of the hot-bed from the manure pile and the scratching of the Australian bush turkey to the burnished symbol of this electric age in such a delightful way. Lost oppor-

tunities are felt in Chapter 4, "The financial side," where a 20th-century Henry Thoreau might have made an enchanting philosophy out of the breakdown of the costs to produce a head of lettuce (2 pence).

This little book can lead to a new hobby for many "do-it-yourself" Americans and may lead to bumper enjoyment, early maturing crops, and possible profit. For Britain, which seems to be passing up this, its wartime development, the author sternly urges a long second look toward "the stepping up of home production, especially in relation to early salad crops."

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**The Physiology of Diapause in Arthropods.** Cambridge Monographs in Experimental Biology, No. 4. A. D. Lees. Cambridge Univ. Press New York, 1955. x + 151 pp. Illus. \$2.50.

The occurrence of a state of arrested growth, or diapause, is common among arthropods and in most cases appears to be under endocrine control. The endocrine centers are in turn responsive to stimuli from the environment and "this link enables the diapause mechanism to function as a timing device synchronizing the periods of dormancy and active growth with the rhythm of the environment in general." Diapause is thus a subject of uncommon interest to both the student of growth and the ecologist. In this newest Cambridge monograph, A. D. Lees summarizes and interprets in skillful fashion the complex and extensive literature of this field.

The author has divided his book about equally between physiology and ecology. He discusses the role of the environment in the onset and termination of diapause, metabolic adjustments in the dormant insect, the endocrine control of diapause, and diapause and phenology. Happily, he does far more than summarize. Lees knows his subject firsthand and makes cogent deductions from the available data. One of his important deductions is that the physiological events causing embryonic diapause are very likely different from those acting in postembryonic life. He concludes that when diapause occurs in the late embryo, the larva, or the pupa, it is usually controlled by the brain or the prothoracic glands. Reproductive dormancy in adult life, by contrast, is presided over by the corpus allatum, while early embryonic diapause is the result of a diapause hormone produced by the mother. Under this view the notion of a unitary theory to explain diapause is wishful. Another interesting conclusion



is that one of the principal adaptive values of diapause is its function in synchronizing adult emergence, a consequence of obvious significance for species with a short adult life.

In addition to its other virtues, the book makes accessible a large number of important findings published in Russian and Japanese. Indeed, almost 15 percent of the 285 references are to papers published in these two languages. The book is thoughtfully written and merits the attention of experimental biologists in general.

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**Aspects of Synthesis and Order in Growth.** Dorothea Rudnick, Ed. Princeton University Press, Princeton, N.J., 1954. vii + 274 pp. Illus. + plates. \$6.

The aspects of synthesis and order in growth presented in this volume are those that were discussed at the 13th symposium of the Society for the Study of Development and Growth at Dartmouth College in June 1954. The 11 contributors have investigated a wide variety of growing things, from microorganisms to vertebrates, and have concerned themselves with the orderly control of many different types of developing systems.

Two papers deal with physicochemical considerations of energetics and molecular topology in the synthesis of proteins: Linus Pauling speaks for a two-step template process, and J. S. Fruton presents an alternative hypothesis. Molecular events are also the primary concern of two other papers dealing with the modification of metabolic pathways in microorganisms.

R. Y. Stanier discusses sequential induction of enzyme systems by substrate modification, and S. S. Cohen writes of unbalanced growth resulting from virus infection. These papers illustrate the fact that investigations of bacterial physiology may contribute not only to concepts of the control of growth but also to concepts of changing metabolic patterns that may be relevant to problems of induction and differentiation in multicellular organisms.

There are two contributions from plant studies. S. B. Hendricks and H. A. Borhwick discuss the synthesis of pigment systems in control of photo-responsive growth, while R. Emerson deals with substances controlling gametophytism versus sporophytism and sex differentiation in water molds.

Two papers concern chick embryos. J. Ebert deals with the topological localization of protein synthesis in the early blastoderm, especially correlating the ap-

pearance of actin and myosin, detected immunobiologically, with morphological data in differentiating heart tissue. N. T. Spratt, Jr., reviews the physiological peculiarities of the organizer center in the chick primitive streak, as revealed by its nutritional requirements when explanted, and compares the node center with the shoot apex.

E. S. Russel reports on the physiological consequences of gene products in the mouse, where the W-series alleles, in chemically specific ways, influence blood formation, gonad development, and coat pigmentation. C. Grobstein is concerned with the synthesis and movement of molecules involved in the induction of mouse salivary and kidney tubule structures. The interacting tissues combined *in vitro* and separated by filters give results supporting the matrix concept in differentiation.

In the final paper, D. Bodenstein discusses the hormonal basis of control over molting patterns in larval and metamorphosing insects. Thus this collection of papers represents approaches to basic problems of growth and development ranging from purely chemical to purely biological considerations. The Princeton University Press has continued the attractive format established 2 years ago when the 11th growth symposium was the first to be published in book form. Although this volume has a 1955 copyright, the title page bears the misleading date, 1954.

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**The Science in Action TV Library.** vol. I. Benjamin Draper, Ed. Merlin, New York, 1956. 157 pp. Illus. \$3.50.

For several years the television program *Science in Action* produced by the California Academy of Sciences has been notably successful on the West Coast. In this book six scripts of the program are presented complete with dialog, camera directions, property lists, and sketches of the layout of the "playing area." The use of the "third camera technic" for effective close-up views is described, and numerous photographs help the reader to understand the way models, diagrams, and working apparatus are used. The program has a standard pattern with Earl S. Herald of the academy as host and a guest scientist who carries on a conversation with Herald as the two move from one part of the playing area to another.

This account probably gives as good a behind-the-scenes view of a scientific television show as could be obtained by any means short of attendance at the conference between writer and guest scien-

tist, the trial rehearsal, the camera rehearsal, and the live program. This book should have value to anyone who is interested in the dignified yet lively presentation of science to the public by way of television or, with slight modifications, by means of movies—G. DuS.

**Corn and Corn Improvement.** Agronomy Monograph, vol. 5. George F. Sprague, Ed. Academic, New York, 1955. xiv + 699 pp. Illus. \$11.50.

This book, as the title implies, is intended to be a comprehensive treatise on the corn plant—its botanical characteristics, climatic requirements, nutritional value—and on its improvement through breeding, cultural practices, and the control of insects and diseases. The book contains 16 chapters, written by 14 authors, all recognized specialists in their respective fields. Since all but two of the authors are stationed in the U.S. corn belt, the book is naturally concerned largely with the corn plant and practices associated with it in terms of corn-belt experience. Only slight attention is given to corn in other parts of the United States where it is an important, although not the major, crop, or in other countries of this hemisphere where it is the basic food plant.

For the corn belt, which is the world's foremost corn-growing region, the treatment is comprehensive and competent. The literature has been thoroughly reviewed, although there are a few curious omissions, and has, with a few exceptions, been objectively presented. The interesting and lively chapter on "History and origin of corn" by Weatherwax and Randolph is marred by several omissions, contradictions, and errors of fact or statement. The otherwise excellent chapter on "Corn breeding" by Sprague inexplicably treats the important contribution of D. F. Jones to modern corn-breeding with a single vague sentence, while devoting pages to technical details involved in the use of Jones' method.

The different chapters vary greatly in length, organization, and technical and literary quality. All are authoritative, but not all are interestingly written. Some chapters are excellent and one, "The cytogenetics of maize" by Rhoades, is distinguished. The general average is good.

Because of the vast amount of material that it contains, and because it represents the most complete summary yet published on the subject, this book will be indispensable as a reference work to anyone having a professional interest in America's most important crop plant.

PAUL C. MANGELSDORF  
Harvard University

**Atomic Energy Research at Harwell.** K. E. B. Jay. Philosophical Library, New York, 1955. 144 pp. Illus. + plates. \$4.75.

The large all-embracing atomic energy laboratories, such as Harwell, or Argonne, or Chalk River, are perhaps the most characteristic postwar scientific organizational developments. These and similar institutions were founded to meet the demands of our highly sophisticated modern technology. They reflect the growing interdependence of the sciences, the gradual blurring of the lines that traditionally have separated the scientific disciplines.

To describe the workings of such an institution is like wandering, as on a Cook's tour, through much of modern science and technology. K. E. B. Jay has covered one segment of this vast ground, Harwell, concisely and with authority. His little book takes one first through the applied projects at Harwell—significantly described as the "main programmes"—continues with a description of how some of the administrative headaches in an enormously large laboratory are dealt with, and then, in descriptions that are sometimes fairly detailed and are always knowledgeable, he covers the basic research at Harwell. His topics range from radioactive waste disposal to capture of  $\mu$  mesons, from turbulence of air to diffusion of argon in silver.

Reading this description of Harwell inevitably invites comparison with the American atomic energy establishments. There is a sort of isomorphism between Harwell and, say, Oak Ridge; it is almost as if the same volume could be used as a description of Oak Ridge or Argonne (or, I suppose, of Saclay or the yet-unnamed U.S.S.R. establishments), if only the names of the people were changed.

Harwell and its American counterparts are such large establishments that in each of them a fair cross section of the scientific personnel of Britain and the United States are represented. These personnel are the products of the respective educational systems, British and American. In this sense the laboratories are large-scale proving grounds for the efficiency of their countries' scientific educational systems; the relative success of these laboratories is a measure of the success of the educational systems that produce them. To judge the over-all merit and success of such large enterprises as Harwell, and, thus, to weigh how the scientific educational systems that underlie them are working, is at best very difficult. Jay's book should be useful in helping scientists outside the British atomic energy framework make such estimates of the United Kingdom effort.

ALVIN M. WEINBERG

Oak Ridge National Laboratory

## Books Reviewed in

### The Scientific Monthly, March

*Adaptive Human Fertility*, P. S. Henshaw (Blakiston Div., McGraw-Hill). Reviewed by J. T. Velardo.

*General Chemistry*, L. E. Steiner and J. A. Campbell (Macmillan). Reviewed by E. L. Gamble.

*The Underwater Naturalist*, P. de Latil (Houghton Mifflin). Reviewed by J. W. Hedgpeth.

*Volume Jubilaire, Victor Van Straelen, Directeur de l'Institut Royal des Sciences Naturelles de Belgique, 1925-1954*, vols. I and II. Institut Royal des Sciences de Belgique. Reviewed by J. M. Berdan.

*Salamanders and Other Wonders*, W. Ley (Viking Press). Reviewed by T. S. Gardner.

*Anxiety and Stress*, H. Basowitz, H. Persky, S. J. Korchin, R. R. Grinker (Blakiston Div., McGraw-Hill). Reviewed by H. Selye.

## New Books

*The Systematic Identification of Organic Compounds*. A laboratory manual. Ralph L. Shriner, Reynold C. Fuson, and David Y. Curtin. Wiley, New York, and Chapman & Hall, London, ed. 4, 1956. 426 pp. \$6.

*College Physics*. C. E. Mendenhall, A. S. Eve, D. A. Keys, and R. M. Sutton. Heath, Boston, ed. 4, 1956. 660 pp. \$6.25.

*Aircraft Today*. John W. R. Taylor, Ed. Philosophical Library, New York, 1955. 98 pp. \$4.75.

*Plane Trigonometry*. Alfred L. Nelson and Karl W. Folley. Harper, New York, ed. 3, 1956. 134 pp. \$3.50.

*Mathematical Theory of Elasticity*. I. S. Sokolnikoff. McGraw-Hill, New York, ed. 2, 1956. 476 pp. \$9.50.

*Fuel*. Solid, liquid and gaseous. J. S. S. Brame and J. G. King. Arnold, London, ed. 5, 1955. 551 pp. \$10.

*Chinese Spirit-Medium Cults in Singapore*. Monogr. on Social Anthropology No. 14, New Series. Alan J. A. Elliott. Department of Anthropology, London School of Economics and Political Science, London, England, 1955. 179 pp. \$2.80.

*A Gallery of Scientists*. Rufus Suter. Vantage Press, New York, 1955. 132 pp. \$3.

*Advances in Veterinary Science*. vol. II. C. A. Brandy and E. L. Jungherr. Academic Press, New York, 1955. 449 pp. \$10.

*The Antarctic Challenged*. Edward R. G. R. Evans (Admiral Lord Mountevans). De Graff, New York, 1956. 247 pp. \$4.50.

*Illuminating Engineering Course*. H. Zijl. Philips' Technical Library, Eindhoven, Netherlands, 1955. 241 pp. \$4.50.

*Introduction to TV Servicing*. For 625- and 525-line receivers. H. L. Swaluw and J. van der Woerd. Philips' Technical Library, Eindhoven, Netherlands, 1955. 264 pp. \$5.50.

*Greek Science in Antiquity*. Marshall Clagett. Abelard-Schuman, New York, 1955. 217 pp. \$4.75.

*A Textbook of Pharmacognosy*. N. M. Ferguson. Macmillan, New York, 1956. 374 pp. \$7.

## Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

*Gravity Survey along the Lines of Precise Levels throughout Japan by Means of a Worden Gravimeter*. pt. VI, Chubu District. Bull., supplementary vol. IV, pt. V. Chuji Tsuboi, Akira Jitsukawa, and Hirokazu Tajima. Earthquake Research Inst., Tokyo Univ., Tokyo, 1955. 112 pp.

National Research Council, Canada. Division of Building Research, Proceedings of the Conference on Building Research, Ottawa, 21-23 October 1953. Bull. No. 1, NRC 3568. National Research Council, Ottawa, Canada, 1955. 137 pp. \$3.50.

California Cooperative Oceanic Fisheries Investigations, Progress Report, 1 July 1953 to 31 March 1955. Marine Research Committee, State of California Dept. of Fish and Game, Sacramento, 1955. 52 pp.

Symposium on Electronics Maintenance. 3-5 August 1955. Advisory Panel on Personnel and Training Research, Office of the Assistant Secretary of Defense, Research and Development, Washington 25, 1955 (Order from Superintendent of Documents, Washington 25). 214 pp. \$1.

*Secondary Elasticity*. A general mathematical theory of elastic secondary stress in continuous media. Monogr. No. 1, vol. 1, ser. 1. P. L. Sheng. Chinese Association for the Advancement of Science, Taipei, 1955. 137 pp.

International Scientific Radio Union, Proceedings of the XIth General Assembly. Held in The Hague, 23 August-2 September 1954. vol. X, pt. 6, Commission VI on Radio Waves and Circuits. The Union, Brussels, 1954. 140 pp. \$3.

*The Fifth Amendment and the Immunity Act of 1954*. Aspects of the American way. Samuel H. Hofstadter. Fund for the Republic, New York, 45 pp.

Committee on Growth, Ninth Annual Report to the American Cancer Society, Inc., July 1953-June 1954. Division of Medical Sciences, National Academy of Sciences-National Research Council, Washington, D.C., 1955. 299 pp. Free.

*Geology of a Portion of the Elsinore Fault Zone, California*. Special Rept. 43. John F. Mann, Jr. 22 pp. \$0.75. *Bibliography of Marine Geology and Oceanography, California Coast*. Special Rept. 44. Richard D. Terry. 131 pp. \$0.75. California Division of Mines, San Francisco, 1955.

Atomic Energy of Canada Limited, Annual Report, 1954-55. Atomic Energy of Canada Ltd., Ottawa, Canada, 1955. 17 pp.

*Spiral Precipitation Patterns in Extratropical Cyclones*. Meteorological Radar Studies, No. 2. John H. Conover. 18 pp. *The Melting Layer*. No. 3. Raymond Wexler. 18 pp. Harvard University, Blue Hill Meteorological Observatory, Milton, Mass., 1955.

*Range of 208 ± 4 MEV Protons in G5 Nuclear Emulsion*. Notas de Fisica, vol. II, No. 3. Hervasio G. De Carvalho and Jerome I. Friedman. Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, 1955. 7 pp.

## Scientific Meetings

### Invertebrate Endocrinology

Preceding the sixth International Anatomical Congress, a symposium on the recent advances in invertebrate endocrinology was held on 23 and 24 July 1955, at the Sorbonne (Laboratoire d'Anatomie et Histologie Comparées), Paris, France. Among the most significant results reported were those dealing with the discovery of two new glands of internal secretion and with the chemical isolation of invertebrate hormones.

The symposium was opened by Karlson (Tübingen, Germany) who isolated one of the developmental hormones of insects (prothoracic gland hormone of *Bombyx mori*). For the crystallized principle whose chemical composition is unlike that of any known vertebrate hormone the name *ecdysone* was proposed (ecdysis, molt). A principle having the same effect in the insect bioassay (*Calliphora* test) can be extracted from the crustacean, *Crangon vulgaris*. Attempts to purify a variety of invertebrate hormones are under way also in other laboratories. L'Hélias (Paris) discussed the role of xanthopterin and isoxanthopterin, which she demonstrated in the brain, corpora cardiaca, and corpora allata of the insect, *Cunicula*. Crustacean chromatophorotropins were extracted by Knowles (Wiltshire, England) and by Östlund and Fänge (Lund, Sweden). The Swedish workers succeeded in isolating a chromatophorotropic principle in highly purified state from the eyestalk of *Pandalus borealis*, and worked out a biological test (Leander unit).

The organs most recently added to the list of invertebrate endocrines are the Y organ and the androgenic gland of crustaceans. The discoverer of the Y organ, Gabe (Paris), presented a detailed morphological and histochemical analysis of this gland. His coworker Echalié (Paris) reported on extirpation and implantation experiments demonstrating that the Y organ controls molting in decapod crustaceans. In addition, the Y organ of *Carcinides* exerts an influence on the gonads (Arvy, Echalié, and Gabe, Paris). The equivalent "molting glands" among insects are the prothoracic (ventral) glands, as was demonstrated once more by the experiments reported by

Joly and coworkers (Strasbourg) and by Wigglesworth (Cambridge, England).

An important contribution to the long-debated question of sex hormones in arthropods was made by Charniaux-Cotton (Paris) who described an androgenic gland in the crustacean, *Orchestia gammarella*. This organ, located at some distance from the gonad, controls primary and secondary male characters in this species.

Extirpation and implantation experiments in gastropods by Laviolette (Lyon) suggest an endocrine control of the genital tract by the gonads. A new possible source of a gonadotropic principle in insects was demonstrated by B. Scharrer (New York): neurosecretory cells (type B) in the subesophageal ganglion of *Leucophaea maderae* show a distinct cytological change after ovariectomy, an observation reminiscent of the occurrence of "castration cells" in the vertebrate pituitary.

Sellier (Paris) suggested that the active principle in the brain of *Gryllus* which inhibits diapause also controls macropterism. Further communications on the cytology of neurosecretory centers in insects and annelids were made by Dupont-Raabe (Paris), Formigoni (Milan), DeLerma (Bari, Italy), and by Herlant-Meeuwis and Paquet (Brussels).

Clark (Glasgow) discussed a hypothesis concerning the phylogenetic origin of primitive neurosecretory elements in polychetes. In nereids neurosecretory brain cells inhibit gonadal maturation and seem to stimulate regeneration (Durchon, Algiers). Atokous and epitokous forms differ with respect to the amounts of polyosides (unrelated to neurosecretory material) in "cytologically active neurocytes" (Defretin, Lille, France). In mollusks (*Chlamys*, *Mytilus*) the disappearance of neurosecretory material from the brain correlates with the stimulation for the emission of the gametes (Lubet, Arcachon, France).

Various other aspects were dealt with in contributions by Drach (Paris) on molting in crustaceans; Possompès (Paris) on insect development; Stephan-Dubois and Lender (Strasbourg) on growth processes in planarians; and Démal (Louvain) on insect differentiation in tissue culture.

The variety of topics discussed reflects the present status of research in invertebrate endocrinology, which is no longer restricted to arthropods but encompasses other invertebrates as well. A more detailed report of the papers presented at this symposium will appear in *Ann. des Sciences nat.*, fasc. 2 (1956).

L. ARVY, M. GABE

Sorbonne, Paris, France

B. SCHARRER

Albert Einstein College of Medicine,  
New York

### Meeting Notes

■ A more rational and productive use of one-third of the earth's surface—the estimated 38 million square kilometers lying in the humid tropical regions—will be studied by an international group of scientists who will meet 19–24 Mar. in Colombo, Ceylon, under the sponsorship of UNESCO.

The meeting will open with a 3-day symposium at the University of Colombo on the study of tropical vegetation. Studies of medicinal plants will be among the subjects discussed by specialists from Belgium, Ceylon, India, Indonesia, Malaya, the Netherlands, Pakistan, the Philippines, the United Kingdom, and the United States.

Following this symposium, 12 scientists will participate from 22 to 24 Mar. in a preparatory meeting on humid tropics research to examine specific activities for the near future. Among projects proposed are the production of maps of humid tropical regions, the classification of vegetation within these regions, the organization of a zoological survey of Ceylon, and the organization of a UNESCO-sponsored advisory committee for humid tropics research.

■ A symposium on Vitamin Metabolism will be held at the Biltmore Hotel in New York on 6 Mar. in conjunction with the 11th annual meeting of the National Vitamin Foundation. The symposium will feature special reports and discussions by a selected group of specialists in the field of nutrition. The sessions will be under the chairmanship of Esmond E. Snell of the University of Texas. Specialists included on the program represent a number of universities and medical centers throughout the country.

■ This year Temple University is sponsoring the tenth annual Eastern Colleges Science Conference 6–7 Apr. More than 500 colleges and universities east of the Mississippi River have been invited to send undergraduate delegates. These students will discuss and deliver research papers in biology, chemistry, geology, mathematics, physics, and psychology.

## **Purina** *laboratory animal* **Nutrition News**

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■ An international mathematical symposium on Algebraic Topology and its Applications is scheduled to take place in Mexico City throughout August. It will consist of brief courses and addresses on recent contributions. It is hoped to bring together the outstanding specialists in the field. For further information, write the secretary, Miss Julieta Silva, Instituto de Matemáticas, Torre de Ciencias, Ciudad Universitaria, México 20, D.F.

■ A Diamond Symposium will be held at the Exposition and Convention of the American Society of Tool Engineers, which is to be held at the International Amphitheatre in Chicago, Ill., 19-23 Mar. Armour Research Foundation is cosponsoring the program. Experts in the field from the Union of South Africa, the Netherlands, Belgium, the United Kingdom, and the United States will participate. J. S. Gillespie, who is in charge of the man-made diamond project at General Electric Company, will open the symposium with a discussion of the current status of man-made diamond, its properties, and possible future uses. The following sessions will be concerned with the production, selection, and industrial utilization of diamond. Among the topics to be discussed are: diamond structure, uses of industrial diamond, suggested standards, selection, and specific applications.

In connection with the symposium, industrial, gem, and man-made diamonds will be displayed, as well as a diamond workshop in which several cutters will be producing diamond tools on machinery shipped from the Union of South Africa and Europe. A working model of the Premier Diamond Mine will also be shown.

■ The European Organization for Nuclear Research (CERN) is making plans to hold a Symposium on High Energy Physics in Geneva, Switzerland, 11-23 June. The main subject for the first week will be "Novel features in the design and techniques of high energy accelerators." This will be followed by papers and discussion on special experimental techniques (for example, bubble chambers) and new contributions to pi meson physics.

Once the program has been established, invitations will be sent to specialists all over the world, and member states will also be invited to send scientists. The total number of participants is not to exceed 300.

■ The Society of American Bacteriologists will hold its 56th annual meeting in Houston, Tex., 29 Apr.-4 May. This will be the first time that the annual meeting of the society has been held in the Southwest. The headquarters for the

meeting will be the Shamrock-Hilton Hotel, where adequate facilities for scientific sessions, visiting, socials, exhibits, and official functions will be available. Persons attending the meeting will be accommodated at the headquarters hotel, the Rice Hotel, and nearby motels.

The first general session of the meeting will be held Sunday evening, 29 Apr. Scientific sessions will start on 30 Apr. and continue through 3 May. Plans are being made for several symposia, including one on "Petroleum microbiology" that will feature a number of professional men from the oil industry. General correspondence concerning arrangements for the meeting may be addressed to the executive vice chairman, Dr. Robert P. Williams, Baylor University College of Medicine, Houston 25, Tex.

## Society Elections

■ American Meteorological Society: pres., Robert D. Fletcher, Washington, D.C.; v. pres., Frederic A. Berry, Washington, D.C.; sec., Henry G. Houghton, Massachusetts Institute of Technology; treas., Henry DeC. Ward, Boston, Mass.

■ Electron Microscope Society of America: pres., W. L. Grube, General Motors Research Department; pres.-elect, J. H. L. Watson, Edsel B. Ford Institute for Medical Research; past pres., T. F. Anderson, University of Pennsylvania; sec., Jeanette R. Cooper, Nela Park 130, Cleveland 12, Ohio; treas., Max Swerdlow, National Bureau of Standards.

■ Indiana Academy of Science: pres., Raymond E. Gorton, Purdue University; v. pres., John D. Mizelle, University of Notre Dame; sec., W. A. Daily, Research Laboratories, Eli Lilly and Company, Indianapolis, Ind.; treas., Frank J. Welcher, Indiana University. Representative to the AAAS Council is Ralph W. Lefler.

■ Mississippi Valley Medical Society: pres., Frank R. Peterson, Cedar Rapids, Ia.; pres.-elect, George E. Kirby, Spring Valley, Ill.; past pres., Arthur S. Bristow, Princeton, Mo.; sec.-treas., Harold Swenberg, 510 Maine St., Quincy, Ill. The vice presidents are C. M. Zukerman (Ia.), W. W. Fullerton (Ill.), Walmun Walters (Minn.), George T. Gafney (Mo.), and Arnold S. Jackson (Wis.).

■ Nebraska Academy of Sciences: pres., Paul Stageman, University of Omaha; v. pres., Robert G. Bowman, department of geography, University of Omaha; sec., C. Bertrand Schultz, director of State Museum, University of Nebraska; treas., Carol E. Rosenquist, University of Nebraska. Representative to the AAAS Council is Victor A. Levine, Creighton University, Omaha, Neb.

## Forthcoming Events

### March

22-25. International Assoc. for Dental Research, St. Louis, Mo. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

28-3. Colloquium on Frontiers in Physical Optics, Boston, Mass. (S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, San Diego 52, Calif.)

29-31. Alpha Epsilon Delta, 11th national convention, Jackson, Miss. (M. L. Moore, 7 Brookside Circle, Bronxville 8, N.Y.)

29-31. Pennsylvania Acad. of Science, Indiana. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

29-31. Southern Soc. for Philosophy and Psychology, Asheville, N.C. (J. E. Moore, Georgia Inst. of Technology, Atlanta.)

30-31. Alabama Acad. of Science, annual, Montevallo. (H. A. McCullough, Howard College, Birmingham, Ala.)

30-31. Seismological Soc. of America, annual, Reno, Nev. (P. Byerly, Bacon Hall, Univ. of California, Berkeley 4.)

### April

2-5. Assoc. of American Geographers, annual, Montreal, Canada. (B. W. Adkinson, Library of Congress, Washington 25.)

2-7. Symposium on Crystallography, Madrid, Spain. (M. Abbad, Serrano 118, Madrid.)

3. Microcirculatory Conf., 3rd, Milwaukee, Wis. (G. P. Fulton, Dept. of Biology, Boston Univ., 675 Commonwealth Ave., Boston 15, Mass.)

3-4. Tissue Culture Assoc., 7th annual, Milwaukee, Wis. (D. C. Hetherington, Duke Univ. School of Medicine, Durham, N.C.)

3-9. International Symposium on Macromolecular Chemistry, Rehovoth, Jerusalem, and Haifa, Israel. (A. Katchalsky, Weizmann Inst. of Science, Rehovoth.)

4-6. American Assoc. of Anatomists, annual, Milwaukee, Wis. (N. L. Hoerr, 2109 Adelbert Rd., Cleveland 6, Ohio.)

4-6. American Soc. of Lubrication Engineers, 11th annual, Pittsburgh, Pa. (Administrative Secretary, ASLE, 84 E. Randolph St., Chicago 1, Ill.)

4-7. International Cong. of Medical Radiography, 2nd, Paris, France. (Secretariat, 66, Blvd. St. Michel, Paris 6.)

5-6. Conf. on Magnetic Amplifiers, Syracuse, N.Y. (C. A. Priest, 314 Hurlburt Rd., Syracuse 3.)

5-7. Optical Soc. of America, Philadelphia, Pa. (A. C. Hardy, Room 8-203, Massachusetts Inst. of Technology, Cambridge 39.)

6-7. American Assoc. of University Professors, St. Louis, Mo. (R. F. Fuchs, AAUP, 1785 Massachusetts Ave., NW, Washington 6.)

6-7. National Speleological Soc., Nashville, Tenn. (Mrs. L. Cutler, 2829 Buchanan St., Arlington 6, Va.)

6-8. American Assoc. of Physical Anthropologists, Chicago, Ill. (J. L. Angel, Daniel Baugh Institute of Anatomy, Jefferson Medical College, Philadelphia 7, Pa.)

7-8. American Soc. of Hospital Pharmacists, Detroit, Mich. (Miss G. Niemeyer, 2215 Constitution Ave., NW, Washington 7.)

7-10. National Assoc. of Boards of Pharmacy, annual, Detroit, Mich. (P. H. Costello, NABP, 77 W. Washington St., Chicago 2, Ill.)

8. American College of Apothecaries, Detroit, Mich. (R. E. Abrams, Hamilton Court, Philadelphia 4, Pa.)

8-10. American Assoc. of Colleges of Pharmacy, Detroit, Mich. (R. A. Deno, Colleges of Pharmacy, Univ. of Michigan, Ann Arbor.)

8-12. Scientific Apparatus Makers Assoc., 38th annual, Belleair, Fla. (SAMA, 20 North Wacker Dr., Chicago 6, Ill.)

8-13. American Chemical Soc., Dallas, Tex. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

8-13. American Pharmaceutical Assoc., annual, Detroit, Mich. (R. P. Fischler, APA, 2215 Constitution Ave., NW, Washington 7.)

8-13. Symposium on Problems of Automation, Milan, Italy. (Consiglio Nazionale delle Ricerche, Ufficio Congressi e Mostre, 7 Piazzale delle Scienze, Rome, Italy.)

9-11. American Assoc. of Feed Microscopists, annual, Terre Haute, Ind. (R. C. Wornick, Agricultural Research Dept., Chas. Pfizer & Co., Inc., Terre Haute.)

9-12. International Anesthesia Research Soc., 30th annual cong., Miami Beach, Fla. (R. J. Whiteacre, 13951 Terrace Rd., Cleveland 12, Ohio.)

10-11. Symposium for Management on Applications of Analog Computers, Kansas City, Mo. (O. Fanning, Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

12. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawes Products, 4800 S. Richmond, Chicago 32.)

(See issue of 17 February for comprehensive list)

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■ **CATALOG** describing various instruments, equipment, and chemicals for nucleonics has been published by Tracerlab. Sections of the 112-page manual

include such items as scalars and accessories, survey meters, Geiger-Müller tubes and accessories, scintillation and safety equipment, and custom, industrial, and medical equipment and service. Catalog D. (Tracerlab, Inc., Dept. Sci., 130 High Street, Boston 10, Mass.)

■ **ADJUSTABLE LEAD SHIELD**, the Atomlab model Als-1.5, is designed for use in making radio-activity measurements on low-activity samples and as a temporary storage for radioisotopes. The shield can be used to improve accuracy in counting problems by placing the Geiger or scintillation counter inside the cylindrical enclosure, which reduces the background count. The function and size of the shield may be varied by the addition or substitution of different sections. (Atomic Center, Inc., Dept. Sci., 489 Fifth Ave., New York 17)

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■ **DRUM CAMERA** model 224 by Beckman and Whitley, which is capable of transporting film at high velocities, offers flexibility in laboratory and field experimentation. As an oscilloscope camera, it has a range of writing speeds from 4 to 400 feet; accessories permit its use as a streak camera or as a framing camera. A 50-in. circumference drum carries the film on its inside cylindrical surface, and a turret-mounted 45-deg first-surface mirror orients the optical axis perpendicular to the plane of the drum. When the drum is driven at its maximum speed of 6000 rev/min, the camera provides 10 msec of writing time on a 35 mm by 50 in. film. (Beckman and Whitley, Dept. Sci., 941 E. San Carlos Ave., San Carlos, Calif.)

■ **UCON FLUIDS AND LUBRICANTS** are described in a new booklet that covers properties, applications, and characteristics of various polyalkylene-glycol derivatives. Form 6500D. (Carbide and Carbon Chemicals Co., Dept. Sci., 30 E. 42 St., New York 17)

■ **RADIOISOTOPE EQUIPMENT** for clinical medicine is described in a new catalog that has been published by Berkeley division of Beckman. Instruments used in medical radioisotope measurements, including gamma detectors, lead absorbers, scalars, meters, monitors, and handling equipment are described. Sketches of clinical applications of radioisotope equipment to diagnose thyroid function, localize brain tumors, or measure blood volume, survival time, and cardiac output are included. Catalog C-201. (Berkeley Div., Beckman Instruments, Inc., Dept. Sci., 22 Wright Ave., Richmond 3, Calif.)

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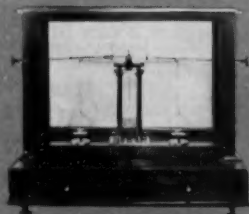
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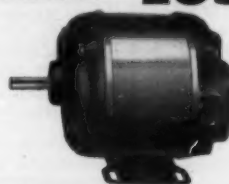
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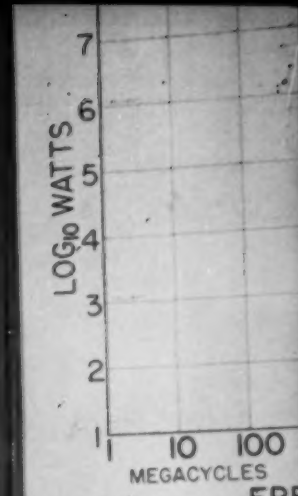
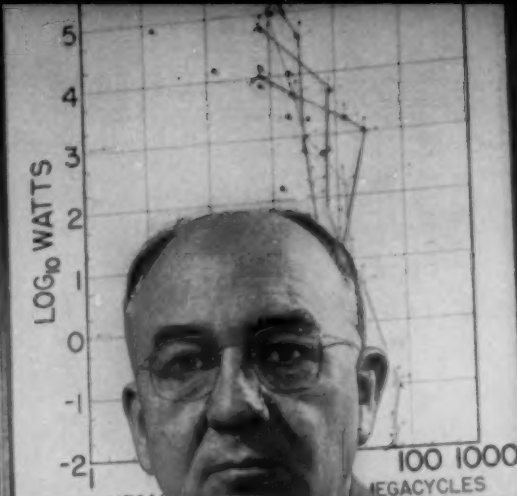
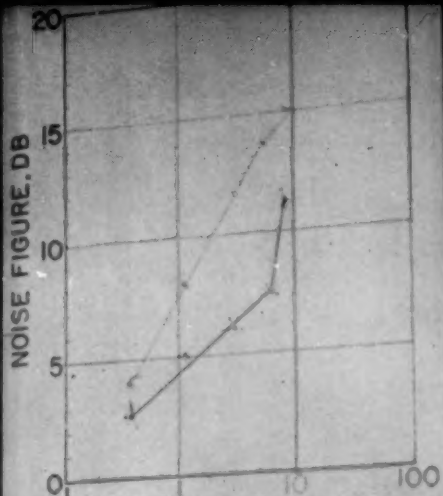
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